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27 January 1986

JAPAN REPORT

SCIENCE AND TECHNOLOGY

CONTENTS

TRANSPORTATION

ELECTRONICS

FY 1985 SEMICONDUCTOR INVESTMENT REPORTED

Tokyo SEMICON DATANET in Japanese May 85 pp 2-3

[Article: "FY 1985 Investment Into Plant and Equipment Expected To Reach the Y1 Trillion Level"]

[Text] Over the period from fiscal 1983 to 1984, the semiconductor industry achieved unprecedented growth. With supply lagging behind rapidly growing demand, helped by the diffusion of office automation equipment and a big increase in VTR production, semiconductor manufacturers revised their capital investment plans upward expecting continued growth of the market and plunged head-on into increased production. Semiconductor production in FY 1984 boomed, reaching Y2.6 trillion in output, a surprising 70-percent increase over 1983. From the fall of last year the boom began to falter, and the semiconductor industry at present is at a turning point. Among the major factors considered contributing to the industry stall are the unexpected slump in demand for semiconductors from VTR's, personal computers, and office automation equipment, and an unbalanced supply and demand situation brought about by rapid increases in supply capacities.

Fiscal 1985 has now started. The situation being as described above, manufacturers are having trouble in drawing up plans for plant and equipment investment for the current year and thus are poised to cope with the changing demand situation with flexibility. The total sum of investment is expected to reach Y1,440 billion, an increase of 15.7 percent over 1984, of which Y850 billion is accounted for by the nine leading semiconductor makers. The increase rate is a far cry from the staggering increase-over-previous year level of above two times achieved in fiscal 1984. The high growth, however, should be regarded as an aberration, and there is no denying that the FY 1985 investment plans represent positive attitudes on the part of entrepreneurs toward investing.

NEC Corporation

In fiscal 1984, NEC produced Y620 billion worth of semiconductors, a 63-percent increase over 1983, and invested Y140 billion in plant and equipment, an increase of 109 percent. It expects a 30-percent increase in semiconductor production to more than Y800 billion for FY 1985, and investment of above Y140 billion.

Yamagata NEC, NEC's production base of bipolar IC and LSI chips, greatly expanded its Tsuruoka plant, and is planning to build a new plant building within 1985 at the earliest. The company is also planning to start, at an investment of Y60 billion, Chugoku NEC in Hiroshima Prefecture, an integrated plant for production of super LSI chips, scheduled to start operation in 1987.

NEC is also building, at a cost of Y30 billion, a plant building for production of custom chips centered on gate arrays at its Sagamihara plant. Upon scheduled completion of the plant in June of this year, NEC will be in a catch-up race with Fujitsu, Ltd., the top runner in the gate array market that has been growing at an annual rate of 50 percent.

Hitachi, Ltd.

Hitachi's semiconductor production in FY 1984 gained 53 percent over the previous year to Y550 billion, and its semiconductor-related capital investment increased 60 percent to reach Y130 billion. As for FY 1985 capital investment, the firm is planning to spend about as much money as it invested in the previous year, Y130 billion, although it says the industry demand for semiconductors is hard to forecast. Sales of semiconductors are expected to gain by 20 percent to nearly Y660 billion.

To beef up its IC and LSI production capacity, Hitachi has been building many new plants across the nation. An MOS LSI wing has been completed at a cost of Y10 billion at its Mobara plant. An LSI wing has been completed this past April, at a cost of Y12 billion, at its Naka plant, which is scheduled to go into full-scale production in October. Hitachi Hokkai Semiconductor Co. is building plants in preparation for the start of operation around October. The aforementioned plants are all for primary processing of MOS LSI's. In the field of final processing, Hitachi Nisshin Electronics Co.'s Tsuchiura plant, and Hitachi Tokyo Semiconductor Co.'s Goshogahara plant as a plant for primary processing of transistors, are slated to start operation this spring. Hitachi Tokyo Electronics Co.'s Yanai plant is to start operation in September. As seen above, plant after plant is to go into operation in 1985; however, Hitachi seems to have no plans for building new plants in the current fiscal year.

Toshiba Corporation

Toshiba's semiconductor sales for FY 1984 surged 57 percent over 1983 to record Y440 billion. Its investment in plant and equipment was Y150 billion. Expecting smooth growth in semiconductor sales in FY 1985, it plans to invest more than Y100 billion to increase output by 25 percent over the previous year to Y550 billion in sales.

Nogata Toshiba Electronics Co.'s Miyata plant No 2 wing, built at a cost of some Y4 billion, is scheduled to start full-scale operation in May; it will be engaged in the final processing of bipolar IC and LSI chips. Toshiba is to inaugurate Kaga Toshiba Electronics Co. in Ishikawa Prefecture. The company is scheduled originally to be engaged in the final processing of discrete chips but as a future goal, it will be turning out IC and LSI chips. Slated for the start of operation in January 1986, construction work is shortly to start at an investment of Y10 billion.

Toshiba is also aggressively tackling research and development. Toshiba Micon Engineering Co. has a newly established design center in Kawasaki City in order to beef up its capacity for design of semiconductors and for development of software for microcomputers. Toshiba is planning establishment of an electronics technology center scheduled for completion in December 1986, which will be engaged in the design and development of custom IC and LSI chips.

Fujitsu, Ltd.

Aiming for sales of Y330 billion worth of semiconductors, Fujitsu invested Y100 billion in FY 1984. The company plans to invest Y100 billion in plant and equipment in FY 1985 and expects a 25-percent increase in semiconductor sales, to about Y412 billion. However, it says that the amount of investment may be curtailed depending on demand for devices.

Work is now underway in Mino Kamo City, Gifu Prefecture, for the construction of an integrated, super LSI manufacturing plant, slated to go into operation in October. The first phase of the project cost Y10 billion, with the total bill to reach from Y50-100 billion over the 5-year period. Fujitsu also intends to invest Y120 billion over the 5-year period in its Wakamatsu plant, a specialized custom LSI plant, making it the company's largest semiconductor plant.

Matsushita-Kotobuki Electronics Industries, Ltd.

Aiming for sales of Y220 billion worth of semiconductors, a 50-percent increase over the previous year, Matsushita invested Y110 billion, a 340-percent increase over the preceding year, in FY 1984. The plans for this fiscal year call for investment of more than Y110 billion and Y300 billion in sales.

These investments are aimed at further beefing up the company's capacity for volume production of 256K DRAM's. At its Uotsu plant that started operation in February, the No 1 wing is being used for production of microcomputers and gate arrays, the No 2 wing for production of bipolar IC chips, and the No 3 wing that is to come on line as early as October of this year is to be used for volume production of 256K DRAM chips. Matsushita is building, at a cost of Y20 billion, a semiconductor research center in Kyoto which is to open this summer at the earliest.

Mitsubishi Electric Corporation

Output of Mitsubishi Electric's semiconductors in FY 1984 failed to achieve the revised plan, registering only Y237 billion in sales. Aiming for sales of Y285 billion for FY 1985, a 20-percent increase over the previous year, the company is prepared to make an all-out effort for accomplishing the target. The firm invested Y70 billion in plant and equipment in FY 1984, and the FY 1985 sum is expected to surpass the FY 1984 level.

This February, the No 2 wing at its Saijo plant was completed at a cost of Y45 billion as a plant for volume production of 256K DRAM chips. The wing is to start operation in July. Work is shortly to begin on the construction of

a third wing, to be used reportedly for production of 256K DRAM's. An investment of Y30 billion is projected for construction of its Kochi plant, a specialized CMOS plant (scheduled to come on line in July 1986). As for research and development, Mitsubishi Electric is building, at a cost of Y18 billion, a super LSI development wing within its LSI Research Laboratory in Hyogo Prefecture. Upon completion in December 1985, the wing will be devoted to development of the next-generation super LSI. A branch office of the LSI Research Laboratory is to be opened in Ofuna, Yokohama City.

Tokyo Sanyo Electric Co., Ltd.; Oki Electric Industry Co., Ltd.; Sharp Corporation

In FY 1984, Tokyo Sanyo produced Y110 billion worth of semiconductors, a 51-percent increase over 1983. It plans to turn out Y143 billion worth of chips, a 30-percent increase, in FY 1985 and to invest Y46 billion, up 40 percent over 1984. The money is to be used for increasing the capacities of Niigata Sanyo Electronics Industries Co. which is the Sanyo Group's key production base of super LSI's and memories, Tokyo IC Co., Tokyo Sanyo's headquarters transistor plant, and R&D center.

In FY 1984, Oki Electric produced Y97 billion worth of semiconductors, representing a 40-percent increase over 1983, and invested Y33.5 billion in plant and equipment. The targets for FY 1985 are Y120 billion in output and investment of Y40 billion.

Investment is to be used mainly for increasing the capacity of the No 2 wing at Miyazaki Oki Electric Industry Co., and for the construction of Miyagi Oki Electric Industry Co. to be undertaken at the end of 1985.

At the end of 1984, Sharp spun off its semiconductor divison to launch it as an independent IC manufacturer. The firm's semiconductor production in FY 1984 was Y45 billion, and the target for FY 1985 is an increase of 33 percent to at least Y60 billion. FY 1984 investment reached Y31.2 billion, and the figure for the current fiscal year is Y30 billion, down 4 percent from the previous year, because movement of the market is unclear.

As seen above, the semiconductor manufacturers are basically taking a positive attitude toward investment. But some are not so enthusiastic about increased spending for plant and equipment, and some makers may revise upward or downward their original capital investment plans depending on the market trends in the first quarter of the year. Thus, the supply and demand movement in the semiconductor market and announcement of revised investment plans by vendors warrant attention.

General News About the Electronics Industry

Exports of electronics parts in January show a good start

According to the customs clearance statistics, exports of electronics parts and components in January showed a good start by registering a 28-percent increase over the same month a year ago to reach Y227.2 billion. Breakdown:

FY 1985 Semiconductor Output and Capital Investment by Nine Leading Chip Makers

(Unit: Y100 million)

Maker	Semiconductor output			Plant and equipment investment	
	FY 84 record	FY 85 original plan	85-84 up (percent)	FY 84 record	FY 85 original plan
NEC	6,200	8,000	30	1,400	1,400
Hitachi	5,500	6,600	20	1,300	1,300
Toshiba	4,400	5,500	25	1,500	1,000
Fujitsu	3,300	4,120	25	1,000	1,000
Matsushita	2,200	3,000	40	1,100	1,100
Mitsubishi	2,370	2,850	20	700	700
Tokyo Sanyo	1,100	1,430	30	345	460
Oki	970	1,200	25	335	400
Sharp	450	600	33	312	300

up 22.7 percent for general electronics parts, to Y125.7 billion, and an increase of 35.1 percent for active parts, to Y101.5 billion.

Among general electronics parts and components, exports of circuit parts such as registers, condensers, and transformers registered an 8.5-percent increase, while functional parts such as motors, microphones, and speakers suffered a 1.7-percent drop. But exports of mechanical components, centered on TV tuners, showed a large increase of 19.6 percent. Exports of tapes also recovered from last year's slump by registering a 37.1-percent increase from the comparable month a year earlier.

As for active parts, no large increases were registered in the exports of electron tubes, up 8.8 percent, and semiconductor elements, up 13.8 percent, but integrated circuits recorded a large increase of 61.5 percent to a total value of Y59.2 billion. Increased exports of active parts centered on IC and LSI chips.

Production of electronics parts and components in January registered a 25-percent increase.

According to MITI statistics, domestic production of electronics parts and components in January showed a 24.8-percent increase over the same month a year ago, for a value of Y484.82 billion, with IC chips leading the surge in output.

By item, production of general electronics parts and components gained a 21.7-percent increase over the same month a year earlier, and active parts and components similarly achieved an 8.9-percent gain in output, while functional parts suffered a 0.7-percent dip. Mechanical components, centered on tuners and switches, gained a 24.9-percent increase.

Actual Production of Active Parts in January 1985

(Unit: millions of yen)

Item	January 1985		Comparison with the same month a year ago--percent		1984 results		Comparison with the previous year percent	
	Number	Value	Number	Value	Number	Value	Number	Value
Semiconductor elements								
Diodes	1,280,917	5,813	- 0.3	- 4.5	18,642,290	88,053	+57.2	+44.7
Rectifier elements	313,631	6,655	+ 8.0	+ 9.0	4,051,255	84,492	32.7	34.4
Transistors	1,157,434	17,178	+20.6	+13.0	14,390,565	224,845	53.3	47.2
Thermistors	16,489	1,064	+32.9	+53.8	167,042	9,701	18.6	18.7
Varistors	37,351	950	- 0.4	+ 3.6	535,876	13,523	27.7	52.8
Photo-electric conversion elements	346,238	10,390	+26.1	+19.4	4,256,749	134,768	42.8	44.0
Other semiconductor elements	26,328	1,702	-41.5	+15.2	106,079	22,396	99.3	80.8
Total semiconductor elements	3,200,241	46,419	+ 9.5	+12.1	42,405,998	610,389	51.0	45.1
Integrated circuits								
Semiconductor integrated circuits	786,424	159,441	+32.2	+51.1	9,178,589	1,828,019	54.2	75.9
Linear integrated circuits	295,639	28,687	30.5	33.8	3,462,615	331,419	53.7	49.1
Industrial machinery use	48,351	5,881	13.9	31.3	653,247	68,541	47.6	52.0
Consumer device use	247,288	22,807	34.4	34.5	2,809,368	262,878	55.2	48.4
Digital integrated circuits	490,785	130,754	33.3	55.4	5,715,974	1,496,600	54.6	83.2
Bipolar type	187,467	22,671	35.2	50.0	2,229,547	261,004	60.8	70.2
Logic chips	183,364	19,150	35.2	47.8	2,188,232	223,726	61.5	71.0
Memory chips	4,103	3,521	36.5	63.3	41,315	37,278	30.3	65.2
MOS type	303,318	108,083	32.1	56.6	3,486,427	1,235,596	50.8	86.2
Logic chips	190,708	40,891	28.3	36.3	2,334,175	481,885	48.6	62.6
Memory chips	105,610	67,191	39.7	72.2	1,152,252	753,711	55.6	105.2
Hybrid integrated circuits	30,630	14,248	33.6	47.4	337,778	145,831	21.0	45.5
Thin-film integrated circuits	1,896	786	54.0	9.5	18,081	10,292	35.1	37.6
Thick-film integrated circuits	28,734	13,463	32.5	50.4	319,697	135,539	20.3	46.1
Total of integrated circuits	817,054	173,689	32.3	50.7	9,516,367	1,973,850	52.8	73.2

(MITI statistics)

Production of magnetic tapes recovered from last year's sluggish growth in the one-digit range to a 12.8-percent gain. As for active parts and components, production of IC chips increased 50.7 percent from the same month a year ago to a value of Y173,668.9 million, while semiconductor elements similarly gained 12.1 percent and electron tubes 21.3 percent. As a whole, production gained a 36.8-percent increase, pushing the total value to Y265.529 million. As with the last year, the growth in production was led by IC chips.

Spending for R&D by leading electronics makers in FY 1985 is to reach the Y1 trillion level.

The total of R&D funding by the leading electronics makers Hitachi, Matsushita, Toshiba, NEC, Mitsubishi, and Fujitsu in FY 1985 is expected to gain a 13.6-percent increase over 1984 to reach Y1.12 trillion, thus surpassing the Y1 trillion level for the first time. Compared with the increase rate of 13.6 percent realized in the previous year, the increase rate for the current year is sluggish, but it still is a two-digit increase.

Notwithstanding the slackening supply and demand situation for semiconductors since the fall of last year, the manufacturers are showing an aggressive attitude toward research and development, and emphasis is placed on R&D of near-term practical devices such as megabit-class super-super LSI's and optical communication systems, and on basic research into devices considered to become practical by the end of the century. Following the lead of Hitachi, which established a basic research laboratory for research into biochips and artificial intelligence, Matsushita and Mitsubishi have also opened similar laboratories for semiconductor research. Judging from the makers' professed determination to increase funding for research and development regardless of slump or boom in the market, investment in research and development is expected to grow steadily in the future.

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ENERGY

MOONLIGHT PROJECT PROMOTES ENERGY-SAVING TECHNOLOGY

Tokyo DENKI TO GASU in Japanese Jun 85 pp 17-21

[Article by Akira Ishihara, Moonlight Project Promotion Office, Ministry of International Trade and Industry]

[Text] I. Importance of Development of Energy-Saving Technology

The supply and demand for oil is at present slackening in the world markets. With the expected recovery in the world economy, the demand for oil, however, is expected to increase particularly in the developing countries. The capacity of the oil-producing countries centered on OPEC to increase output, however, is limited, so the general consensus is that the oil supply and demand situation will again become tight in the 1990's, accompanied by probable rises in prices.

The world oil situation is fluid and so correct prediction of future trends in the supply and demand for oil and in its prices is a matter of great difficulty. When the instability of the Middle East situation is taken into account, the situation surrounding oil is considered to contain a large unstable factor. Therefore, measures will have to be continuously implemented to establish a stability in energy supply and demand. Energy conservation which is one of the most promising policy choices for Japan, poor in energy resources and impervious to external factors like international situations, is expected to have a great degree of beneficial effects on its own merit. So, the policy is one of our country's priority tasks.

In promoting energy-saving, development of energy conservation technologies aimed at raising energy efficiency in the fields of energy conversion, its transportation, its storage, and its consumption is considered, along with enactment of legal actions urging rational use of energies and implementation of an enlightenment campaign for energy conservation to play a crucial role.

Based on such a point of view, the Moonlight Project, an energy-saving technology development project started in 1978, has been promoted in a comprehensive and systematic way by mobilizing the resources of the national research laboratories, industry, and universities.

Under the Moonlight Project, technical development is at present being centered around the following six pillars: 1) large-scale energy-saving

technology; 2) pioneering and fundamental energy-saving technology; 3) international cooperative research project; 4) research and survey of energy-saving technology; 5) energy-saving technology development by private industry; and 6) promotion of energy-saving through standardization.

II. Outlines of Moonlight Project

Large-scale Energy-saving Technology

Under this program, large-scale energy-saving technology development projects in which R&D would take a longer period of time and require a greater investment of money than any single firm could undertake on its own will be undertaken as national projects, making them targets for cooperative R&D by the national laboratories, industry and universities. At present, R&D is being conducted in the following five projects: high-efficiency gas turbines, new types of storage batteries, fuel cell power generation technology, a general-purpose Stirling engine, and superheat pump/energy accumulation systems.

Going into the seventh year of its life, the Moonlight Project has already completed what may be called the shortest way to energy-saving technology, a project for utilization of waste heat (recovery and effective utilization of heat discharged from factories), and practical use of the absorption type heat pumps and heat pipes is progressing at a rapid pace. The 1984 contract, the largest in the world, to export absorption type heat pump systems to the Netherlands for use in regional heating and cooling is one example of the Moonlight Project's accomplishments.

As for the magnetohydrodynamic (MHD) power generator project (electric power is generated directly by passing a high-temperature gas through a strong magnetic field), the second phase of the program aimed at development of a long-life channel has already been completed, and at present fundamental and pioneering research into a coal-fired MHD generator is being promoted.

R&D of Fundamental and Pioneering Energy-saving Technology

While striving under this program for the discovery of seeds for future large-scale energy-saving technologies, R&D of fundamental energy-saving technologies for industry is being undertaken by national laboratories.

At present, research is being conducted into 11 themes, including potassium turbine technology and superconductive power transmission technology.

International Cooperative Research Projects

For efficient promotion of the efforts for development of energy-saving technology, Japan will have to be at all times abreast of progress in research and development at home and abroad and of the movements of related technologies. It will also have to cooperate, as needed, with other countries in technical development projects.

Japan Has Been Participating in IEA-sponsored Energy-saving Projects

While continuing research on the IEA-sponsored advanced type heat pump system Annex IV (heat pump center), Japan is also scheduled to take part in Annex IX (industrial heat pump) in fiscal 1985 and to simultaneously promote bilateral cooperative projects, such as the Japan-France cooperation.

Feasibility Studies for Energy-saving Technologies

Besides conducting "a survey for the establishment of methods of grasping the comprehensive effects of energy-saving technologies" in an effort to establish the optimal methods for R&D of energy-saving technologies, as well as for the discovery of related technical tasks from fiscal 1985, feasibility studies are to be conducted of specific tasks.

Included among such specific tasks are feasibility studies of machinery for superconductive power generation and their material technologies. Their purpose is to grasp the effect of superconduction in power generation on the energy-saving efficiency and on the power generation and distribution system from the point of view of technology and economics, and thus, to forecast the trends of those technologies.

Giving Subsidies to Private Efforts for Development of Energy-saving Technologies

Under this program, the government gives subsidies to the most important of energy-saving technology development projects undertaken by private firms to give the R&D incentives and to facilitate the smooth practicalization of the technologies thus developed. Funding for the program comes from "the system for subsidizing R&D of important technologies" and "the system for subsidizing practicalization of oil-alternative, energy-related technologies." The fruits of R&D all belong to the private firms, thus contributing to the invigoration of cooperation among private firms in research.

Promotion of Energy-saving Through Standardization

From the viewpoint of promoting energy saving under this program, new provisions are added to the Japanese Industrial Standard (JIS) or standards in it are revised. Furthermore, taking advantage of the JIS mark system, a system in which mining and industrial products whose quality and performance are meeting with the JIS standards are labeled with a JIS mark, necessary information is provided for the consumers to help them in their selection of consumer goods and to show them ways in which those goods can be put to use in the most energy-efficient way.

Studies aimed at grasping the basic items required in promoting energy-saving in fiscal 1985 are to be made of the standards for such items as energy-saving type building materials and equipment, energy-saving type industrial kilns and furnaces, and the combustion performance of energy-saving type gas burners.

The aforementioned programs are tabulated into the following table by source of funding:

Outline of Projects Planned for Execution in FY 1985 Under Moonlight Project

(Unit: millions of yen)

Item	FY 84 budget	FY 85 budget (draft)	Major projected plans for FY 85
1. Solar energy	8,897	9,169	(1) Development of practical technology for solar light power generation (2) R&D of solar light power generation (3) Research and analysis of solar heat power generation plant (4) Development of solar systems for industrial use
General account	1,175	810	
Special account	7,722	8,358	
2. Geothermal energy	6,885	7,336	(1) Comprehensive survey for geothermal resources across the nation (2) Verification tests of geothermal prospecting technologies (Sengan & Kurikoma areas) (3) Environmental preservation verification tests for great depth geothermal power plants (Bungo/Hizen area) (Funding in the Natural Resources and Energy Agency budget) (4) Development of hydrothermal power plants (*1,623→*2,022) (Of the sums, appropriations for high temperature rock-based power generation systems *618→*727) (5) Development of great depth hydrothermal water supply systems
General account	1,020	858	
Special account	5,865	6,478	
3. Coal energy	22,411	25,654	(1) Development of a liquefaction plant (*17,883→*20,770) (Of the sums, *2,103→*3,412 for bituminous coal liquefaction) (Of the sums, *14,783→*16,470 for brown coal liquefaction) (ANRE appropriations) (2) Development of a high calorie gasification plant (3) Development of a low calorie gasification plant
General account	590	561	
Special account	21,821	25,093	
4. Hydrogen energy	289	256	(1) Development of hydrogen manufacturing technology (2) Development of hydrogen transport and storage technology
General account	289	256	
5. General research	768	663	(1) Ocean energy (173→159) (2) Development of wind power power generation (*322→*250)
General account	445	412	
Special account	322	250	
6. International cooperation	71	71	(1) Participation in IEA projects (2) Japan-Australia bilateral cooperation
General account	71	71	
7. Others	487	627	(1) Costs of dismantling R&D facilities (2) Management costs, etc.
General account	60	53	
Special account	427	574	
Total	39,809 [36,813]	43,776 [39,813]	
General account	3,651 [3,651]	3,022 [3,022]	
Special account	36,158 [33,163]	40,754 [36,791]	

Note: 1. Figures with * show the funds are appropriated in the special accounts. Project promoters is New Energy Development Organization.

2. Figures include funds appropriated in the Agency of Natural Resources & Energy budget. Figures in [ ] are totals of appropriations in the Agency of Industrial Science & Technology budget.

III. Current State of Large-scale Energy-saving Technologies and Their Prospects

1. High-efficiency Gas Turbines

Even the most advanced of steam turbines, the main force in current thermal power generation, have a thermal efficiency of about 40 percent, and the value is said to be the technical limit of the technology. The technology expected to break the steam turbine's technical wall is combined power generation, in which a gas turbine is combined with a steam turbine that is actuated by the recovered heat from the gas turbine exhaust.

In Japan combined power generation systems incorporating simple cycle gas turbines, built at the Higashi Niigata thermal power plant of the Tohoku Electric Power Co. and at the Futtsu thermal power plant of the Tokyo Electric Power Co., have been in operation. These systems are said to have a thermal efficiency of about 43 percent. In the case of the high-efficiency gas turbine project which is being run as part of the Moonlight Project, the target is development of a combined power generation system with a thermal efficiency of 55 percent (LHV standard) by developing a reheat cycle gas turbine.

As an intermediate goal to this project, the design and manufacture of a pilot plant incorporating a 100,000-kilowatt-capacity gas turbine with a 50-percent thermal efficiency (LHV standard) was started in fiscal 1978. Through the adoption of high technologies, unprecedented in the world, such as the inlet temperature of 1,300°C, pressure of 55 kg/cm^2, and reheat, the gas turbine has succeeded in gaining a high efficiency and an increased specific power. The pilot plant, developed by Engineering Research Association for Advanced Gas Turbines, was tested in 1983. Installed at Tokyo Electric Power Co.'s Sodegaura thermal power station, the plant has been in operation since March 1984 for on-site trial runs and verification operations. In order to confirm the system's safety and reliability under load, the pilot plant is scheduled to be subjected to various kinds of performance tests, including synchronous making capacity and full load operation. The plant has so far generated a total output of 1,983 MWH, logging a total of 109 hours in operation. It has realized an output of 66,000 kw and an inlet temperature of 1,260°C, the world record in its class. According to plans, the verification operation is to continue into fiscal 1985, and after that the plant is to be opened for inspections to confirm its safety and reliability.

New Types of Power Storage Battery Systems

Keeping electric energy in storage is difficult, so the output of power generation must be adjusted according to demand. The demand for electric power fluctuates greatly even during a single day. When peak demand from 1300 to 1500 is counted as 100, the demand drops to between 30 and 40 at midnight (from 0300 to 0500). A large-scale power plant, on the other hand, can achieve high efficiency only when it is run under a certain load. Keeping the capacity of power generating facilities at a level capable of meeting the peak demand during the daytime in summer is a waste from the viewpoint of operations efficiency, helping to raise the costs of electricity. One way to achieve

efficient utilization of facilities (load leveling) is to cope with fluctuations in the demand for electric power by keeping in storage the surplus electric power during the night and by discharging it during the peak demand hours in the daytime.

Under this project, using new types of large-capacity and high-efficiency batteries, research has been going on since 1980 for the development of electric power storage systems with a load leveling function, in which electric power is kept in storage (charge) by means of electrochemical reaction during off-peak hours and is released (discharge) during peak hours.

The requirements for the system when commercialized are the following: 1) it has a cost efficiency on a par or better than a pumping-up power plant; 2) it can be installed in a city or its vicinities; and 3) it can be installed in a space smaller than that needed for a substation.

Development is underway on the following four types of batteries, each with specific characteristics: 1) sodium-sulfur battery; 2) zinc-chlorine battery; 3) zinc-bromine battery; and 4) redox flow type battery. The timetable calling for research on element technologies in the FY 1980-1981 period and development of four types of 1-kw-class batteries in the 1982-1983 period for intermediate evaluations (on battery capacity, charge, and discharge efficiency, battery load rate) has been approved as appropriate. As a next step, manufacture of 10-kw-class of batteries is scheduled for the FY 1984-1986 period. After FY 1987, demonstration tests are scheduled for a 1,000-kw-class power storage system using a new type of battery considered most suited for that purpose.

Fuel Cell Power Generation Technology

What is being aimed at under this project is development of a technology in which power is generated directly by an electrochemical reaction of hydrogen obtained by reforming fuels such as natural gas, coal gas, and oxygen in the air. Since they take advantage of an electrochemical reaction, fuel cells of even a small scale have a high power generating efficiency ranging from 40 percent to 60 percent, and moreover they show no large reductions in efficiency even when run under partial load. For these features, fuel cells are suited for use for meeting intermediate load or peak load. Clean and emitting lesser amounts of exhaust gas, and, furthermore, free from noise or vibration, fuel cells are highly suited for dispersed installation in areas adjacent to big cities or in cities. When the resulting reductions in transmission losses are taken into account and when the waste heat is used for the purpose of heating or cooling or hot water supply, the total thermal efficiency of fuel cells can be raised to 80 percent, contributing to enhanced energy-saving.

Development of the following four types of fuel cells started in FY 1981 as part of the Moonlight Project.

(1) Phosphoric acid type fuel cell

Toward the goal of completing the design, manufacture, and running research of a 1,000-kw-class fuel cell plant by FY 1986, development of the fuel cell proper and peripheral technologies such as fuel reforming equipment is underway.

Under the initiative of the New Energy Development Organization (NEDO), the research is being conducted simultaneously on two systems, a low-temperature and low-pressure type (190°C and 4 atmospheric pressures) plant designed for mainly dispersed installation in urban cities and a high-temperature and high-pressure type (205°C and 6 atmospheric pressures) plant designed for use as a replacement to a thermal power plant.

(2) Molten carbonate type fuel cell

Not only is the carbonate fuel cell more efficient (above 45 percent) than the phosphoric acid fuel cell, but it is of a high-temperature type device (about 650°C). So the waste heat can be recovered to generate more electricity in a bottoming cycle, thus further raising the system's efficiency.

The development is currently at the stage of research into fuel cell materials and element technologies, and the plan calls for construction of a 10-kw-class bench plant by FY 1986 for research on operational runs. Awaiting the results, the policy for the development of a commercial plant is to be decided.

(3) Solid electrolyte type fuel cell

The solid electrolyte fuel cell has an even higher working temperature at about 1,000°C. The development is currently at the stage of development of element technologies. Not only is the solid electrolyte fuel cell expected to achieve a high power generating efficiency of about 50 percent, but the waste heat it generates could be used more effectively than the molten carbonate type cell. The fuel cell proper for a several hundred kilowatts class plant is to be developed by FY 1986.

(4) Alkaline type fuel cell

Differing from the three types of fuel cells described, the alkaline fuel cell operates at the normal temperature, making it relatively easier to maintain and control. But reformed hydrogen from natural gas and coal gas cannot be used as its fuel since they contain a large amount of carbon dioxide. Therefore, alkaline fuel cells are expected to be used for such special purposes as in spaceships, in or around chemical plants where hydrogen is obtained as a byproduct, or in the days when hydrogen energy technology has been commercialized in the future.

General-purpose Stirling Engine

Differing from the internal combustion engines widely used in the private sector, Stirling engines are external combustion engines.

Helped by the rapid advances in the material and sealing technologies in recent years, the excellent characteristics of the Stirling engine are being reviewed with renewed interest. These features are: 1) high efficiency--the working cycle of the Stirling engine is about as high as the Carnot's cycle, and theoretically, it can attain the highest thermal efficiency achievable as a thermal engine, 2) low pollution--since the Stirling engine does not have the explosion process characteristic of internal combustion engines, the engine itself produces less vibration and noise, and the exhaust gas can be cleaned up with ease, and 3) diversity in fuel choices--since the Stirling engine is an external combustion engine, such a large variety of fuels can be used, including coal and wood-based fuels that cannot be used in conventional engines, in addition to oil and natural gas. Under this project, R&D has continued since FY 1982 on the Stirling engines' applications in home and business types of air-conditioning equipment and in small-size power generators. At present, the Mechanical Engineering Laboratory is conducting tests on the various types of engines for their intermediate evaluation.

Super-heat Pump/Energy Accumulation System

Started in FY 1984, this project aims at development of a "Super-heat pump/energy accumulation system," in which surplus electricity during the night is kept in storage as high-efficiency and high-density energy for retrieval during the daytime when much energy is needed as hot heat or cold heat for use as a heat source for air conditioning large buildings, for large-scale community-wide heating or cooling, or for process heat in various industries, thus contributing to leveling loads for electric power. To that end, the targets in the R&D activity are development of super-high-performance compression type heat pumps and of element technologies for chemical heat storage. The results of all this are expected to culminate as an optimal total system, which will be run for operational research.

The commercial plant of a 30,000-kw class in thermal output, the ultimate goal of this project, will be able to provide a 5,000-unit class housing complex with air-conditioning and hot water supply amenities. This project, however, is not designed to implement a large-capacity system of this kind, but rather to develop a conceptual design for such a system. Actual R&D is limited up to plants of the 1,000-kw class. The prospects are bright for the commercialization of the 1,000-kw class of plants, which have a capacity to air condition a bulding 8 to 10 stories high.

20,114/9365
CSO: 4306/3553

NEW MATERIALS

PRODUCTION, APPLICATION OF PIEZOELECTRIC CERAMICS DESCRIBED

Tokyo NIKKO MATERIALS in Japanese Apr 85 pp 1-4

[Article by Jiro Inoue, Murata Manufacturing Co., Ltd.: "Piezoelectric Ceramics: Progress of Technical Development and Growth of Application Field"]

[Text] 1. Introduction

Piezoelectric materials are those where electric energy and mechanical energy can be converted to each other. Besides ceramics, piezoelectric materials include single crystals such as quartz, thin film such as zinc oxide (ZnO), and high polymers such as polyvinylidene fluoride (PVDF). Among these, lead zirconium titanate (PZT) and other piezoelectric ceramics, as well as quartz, are most often used. This is because piezoelectric ceramics have the following characteristics:

1) can be moded into the desired size and form;
2) excellent in mass productivity and low in cost;
3) have large k, electric mechanical coupling constant, making it possible to control mechanical Q (Qm) and ε;
4) have good temperature property and chronological stability.

In this article the author will outline the production method and various applications of piezoelectric ceramics.

2. Theory, Types, and Production Methods

Figure 1 shows the classification of all crystals in terms of piezoelectricity. Most of the piezoelectric ceramics belong to ferroelectrics. Piezoelectric ceramics are multicrystals made up of fine crystal particles. Their orientation of spontaneous polarization after baking is random without showing piezoelectricity as a whole. By exposing them to a strong electric field of direct current, the orientation of the spontaneous polarization can be unified, which remains as residual polarization even after the external electric field is removed. Thus, by taking advantage of their ferroelectricity, piezoelectric ceramics are made to have piezoelectricity before use. This process is called polarization treatment. Used as piezoelectric ceramics according to their applications are: barium titanate ($BaTiO_3$), the first one found to have piezoelectricity; PZT which is the solid solution of ferroelectric lead titanate ($PbTiO_3$) and antiferroelectric lead zirconate ($PbZrO_3$), in a proportion

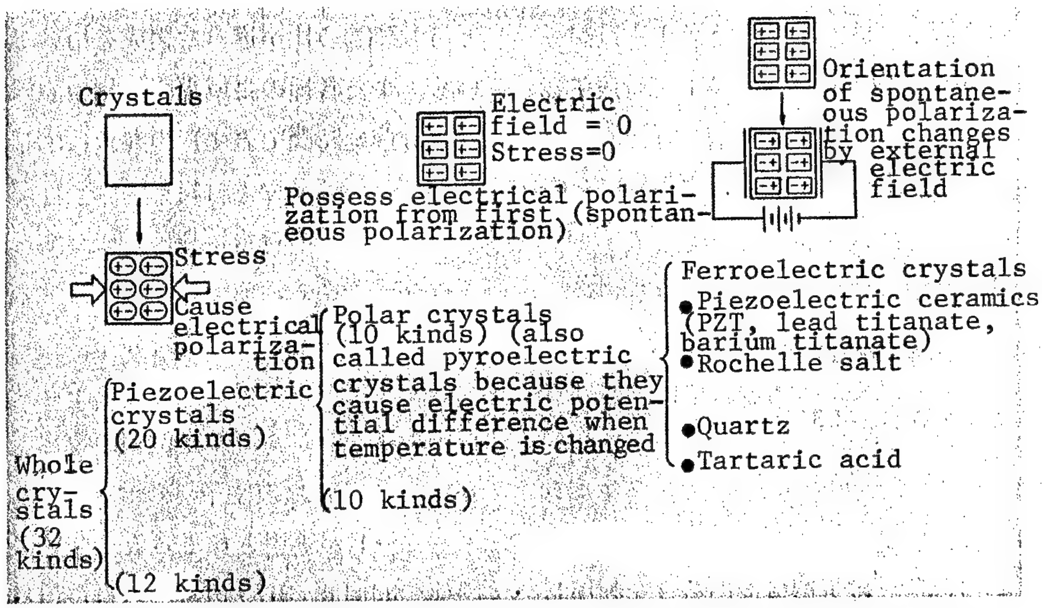


Figure 1. Classification of Crystals by Piezoelectricity

of 1 to 1; and the three-ingredient group ceramics, which are the solid solution of PZT and a third ingredient such as $Pb(MgNb)O_3$.[1,2,3]

Characteristics of the representative piezoelectric ceramics currently mass-produced by Murata Manufacturing Co., Ltd. are shown in Table 1. These materials are only representative ones. For actual application to commercial products the company has developed ceramic materials most suited to use for respective purposes.

The conventional method of molding piezoelectric ceramics is to press the powder into the form, which then is baked and ground. Also employed recently, depending on the purpose, is the wet method where green sheet is prepared and punched before baking.

Discussed below are materials and their applied products for respective purposes.

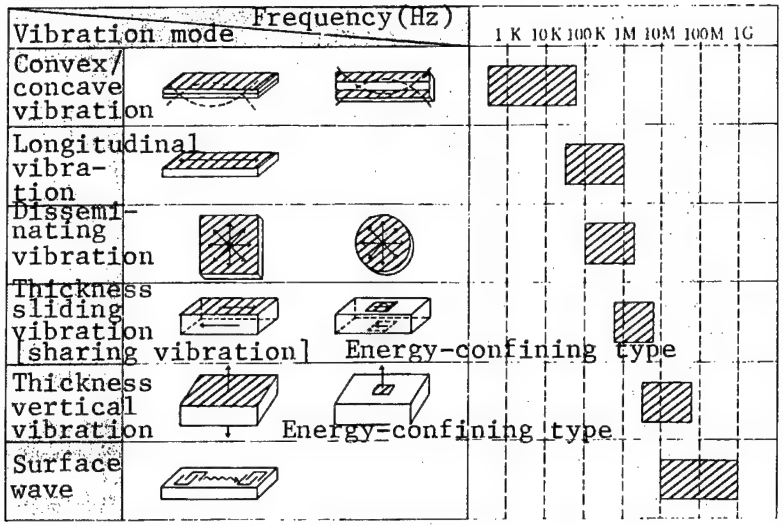
3. Application as Ceramic Filter and Materials Used

The ceramic filter has the largest market among commercial products where piezoelectric ceramics are used. Ceramic filters utilize the piezoelectric ceramic properties of mechanical resonance and dielectric/mechanical energy conversion. Vibration modes are selected, in the way elements can form the size and shape possible to work on, according to the frequency belt in the wide frequency range of 100 KHz to 30 MHz. Table 2 shows vibration modes and usable frequency belts. AM radio, with its intermediate frequency (IF) being 455 KHz, uses the disseminating vibration of square plate, and FM radio, with IF of 10.7 MHz, uses energy-confirming type thickness vertical vibration. Television, with sound intermediate frequency (SIF) of 4.5-6.5 MHz, uses thickness vertical or thickness sliding energy-confining type vibration.

Table 1. Examples of Piezoelectric Materials (Piezotite® by Murata)

Characteristics	Sign	Unit	Name of materials						Notes
			P-3	P-5	P-5D	P-6C	P-6E	P-7	
Specific dielectric constant	$\varepsilon_{33}^T/\varepsilon_0$		1170	1600	1200	810	1420	1960	Measured at 1kHz
Dielectric loss	$\tan\delta$	%	0.5	1.2	0.8	0.9	1.3	1.9	
Piezoelectric constant	d_{31}	$\times 10^{-12}$m/V	−58	-162	-121	-42	-100	-184	
	d_{33}		172	349	286	126	239	391	
Voltage output coefficient	g_{31}	$\times 10^{-3}$ Vm/N	−5.3	-11	-11	-6	-8.3	-10	
	g_{33}		15	22	24	16	18	20	
Electric mechanical coupling constant	k_{31}		0.19	0.35	0.33	0.16	0.26	0.34	
	k_{33}		0.49	0.65	0.66	0.44	0.60	0.68	
	k_p		0.32	0.55	0.55	0.37	0.45	0.59	
Mechanical Q	Q_m		970	230	236	850	420	91	radial vibration
Frequency constant	f_c	Hzm	3150	2090	2160	2520	2320	2020	
Coercive electric field	E_c	V/mm	400	750	1300	2000	1510	815	
Density	ρ	$\times 10^3$kg/m³	5.38	7.27	7.58	7.5	7.42	7.62	
Young's modulus	Y_{11}^E	$\times 10^{10}$N/m²	11	6.9	7.8	10.3	8.5	6.1	
Curie temperature	T_c	℃	110	245	295	330	275	320	
Heat expansion coefficient	α	$\times 10^{-6}$/℃	15	2.7	2.4	——	1.4	1.8	radial vibration
Frequency temperature coefficient	C_{fr}	ppm/℃	——	-440	——	——	+35	+30	-20°-80°C of temperature range
Special resistance at 20°C	R	Ω -cm	6.3×10^{11}	3.6×10^{10}	1.8×10^{11}	——	9.8×10^{10}	2.6×10^{11}	Measured at 500V/mm

Table 2. Vibration Modes and Applicable Frequency Belts



Since temperature property changes from one vibration mode to another, PZT's of different $PbTiO_3/PbZrO_3$ proportions are used for the respective modes. Also, in accordance with the different demands for the width of the belt and linearity of the mode (expressed by group delay time), materials of different k, Qm, and ε are used. Their material properties are controlled not only by the composition ratio of the two ingredients or the three ingredients but also by additives.

Besides use as filters, piezoelectric ceramics are used as FM wave inspection element (discriminator), taking advantage of impedance and phase change of the ceramic resonator.[4] They are also used as a trap to remove sound signal in the picture intermediate frequency (PIF) television signal. These parts are becoming increasingly important because radio and television circuits have become more and more integrated to reduce the number of adjustment sites.

4. Application as Surface Wave Filter and Materials Used

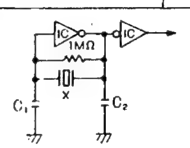
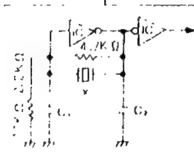
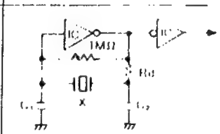
The surface wave filter is made of a piezoelectric substrate on which interdigital electrodes (IDT) are installed to form a filter with the wave transmitted on the surface to the substrate. It is often used for 38.9/45/58 MHz for PIF of television.

Used as the piezoelectric substrate material are single crystals such as $LiTaO_3$, sputtering film such as ZnO, and also PZT. Compared with other materials, PZT features mass-productivity and large k. Requirements for PZT to be used as the surface wave materials include low ε, needed for impedance matching in high frequency; and absence of pores because pores on the surface influence IDT structure, transmission loss, and unevenness of sound speed. Such processes as hot press and atmospheric baking are used to produce ceramics without pores.[5]

5. Application as Ceramic Oscillator and Materials Used

Recently, use of the one-tip microprocessor has been promoted to control a wide range of machine and equipment such as audio/video equipment, office automation machines, domestic appliances, and automobiles. As the source to generate the standard signal which is indispensable in operating such a microcomputer, a ceramic oscillator of 190-30 MHz is used. Since accuracy and stability of about 1/1000 are enough for standard oscillation, this is the most suitable market for small-size low-cost ceramic oscillators. The ceramic oscillator is easy to use in that it is less influenced by the capacity of outer circuits compared with quartz of small ε. Table 3 shows types of ceramic oscillators. The vibration modes used are the same as those in Table 2. Materials used are those which have high Qm and are excellent in temperature property and chronological change.[6]

Table 3. Characteristics of Ceramic Oscillator (Cerarock® manufactured by Murata)

Items	CSA series (MOS specification)			CSA series (LS-TTL specification)				CSB series
	CSA☐MK	CSA☐MG	CSA☐MT	CSA☐MK11	CSA☐MG11	CSA☐MS11	CSA☐MX11	
Frequency range	0.8~2.3MHz	2.4~6.4MHz	5.0~14.0MHz	0.8~2.3MHz	2.4~4.9MHz	5.0~9.9MHz	10~30MHz	190~1250KHz
Oscillation frequency Early period deviation	±0.5%			±0.5%			±0.3%	±1KHz(190~374KHz) ±2KHz(375~800KHz) ±4KHz(801~999KHz) ±0.5%(1000~1250KHz)
Oscillation frequency Temperature stability	±0.3%		±0.5%	±0.3%		±0.3%	±0.3%	±0.3%
Chronological change	±0.3%		±0.5%	±0.3%		±0.5%	±0.3%	±0.5%
Oscillation frequency	 IC : 1/6 CD4069UBE×2 V_{DD} : 5V (12V for MT series) X : Cerarock® C_1,C_2 : 30pF			 IC : 1/6 SN74LS04×2 V_{CC} : 5V (power source voltage) X : Cerarock® C_1,C_2 : Outer capacity				 IC : 1/6 CD4069UBE×2 V_{DD} : 5V X : Cerarock® C_1,C_2 : Outer capacity Rd : 5.6KΩ

6. Application as Audio Equipment and Materials Used

Piezoelectric buzzers and piezoelectric speakers have been rapidly diffusing over the past several years. Demand is increasing because of their simple structure, small size, and economic merit, and also improved sound quality as a result of successful reduction in thickness. Recently, they have been used particularly for telephone sets, not only as ringer but also as transmitter and receiver. Figure 2 shows the characteristics of a piezoelectric transmitter/receiver. Their basic structure is the monomorph structure made of thin piezoelectric ceramic plate glued on the metal plate to utilize the convex/concave vibration. The reason for using the convex/concave vibration is to generate low frequency in the audio field and to match the acoustic impedance with air. Since low impedance and high electric/mechanical energy conversion ratio are required to elevate sound pressure, materials of high ε and large k are used for this purpose.

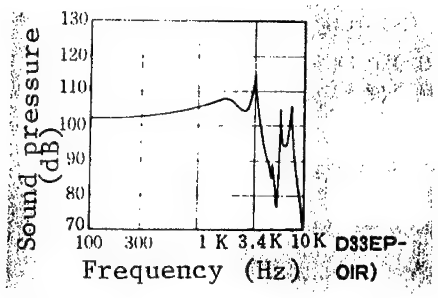


Figure 2. Receiving Characteristics of Piezoelectric Transmitter/ Receiver (PDK33EP-OIR manufactured by Murata)

7. Application as Ultrasonic Vibrator and Materials Used

Electric/mechanical energy conversion device (transducer) using piezoelectric ceramics was practically applied in the ultrasonic area earlier than others. In-the-air transducer is generally referred to as ultrasonic microphone and is used, among others, for remote-control equipment, burglar-alarm system, and vehicle detector. This uses convex/concave vibrator similar to piezoelectric buzzer; and its frequency is 20-80 KHz. Figure 3 shows an example of ultrasonic microphone.

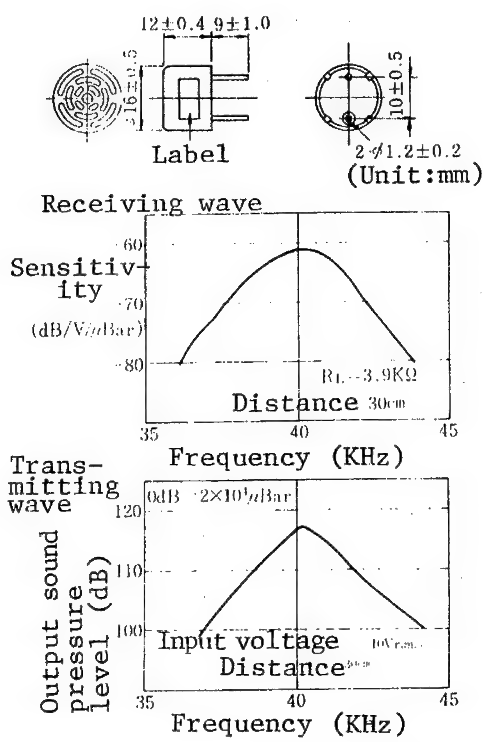


Figure 3. Ultrasonic Microphone (MA40A3 manufactured by Murata)

As in-the-water device, the Randuban model has long been used for fish shoal detector and depth sounder. The frequency used is 40-200 KHz. As medical equipment, diagnostic equipment with arrayed vibrators of several MHz is

widely used. As the device for solid substance, wound detector is available. Recently, studies are active on ultrasonic microscope to see the inside of the IC.

Application other than transducer sensor is ultrasonic delay line. This is for television and VTR to delay signals by one-hour period by changing the electric signals to transverse wave in the glass used as the medium to delay the signals. In order to change the signals to slow speed of transverse wave, PZT of sliding vibration is used.

For these transducers, matching of acoustic impedance with the medium is important. Required materials are those of high d and g constants. Also, for high power equipment such as fish shoal detector, consideration should be given to the heat to be generated by internal loss.

Devices using the energy of ultrasonic wave for machining or moistening include welder, wire bonder, cleaner, and moistener. These also are operated at high power and in their design consideration should be given to internal heat generation.

8. Other Applications and Materials Used

Sensors to detect mechanical signals (speed acceleration) such as a knocking-sensor for automobiles and a sphygmomanometer sensor are increasing in number. These sensors use materials of large piezoelectric g constant.

Also, a piezoelectric lighter to ignite gas by impact and generating high voltage requires materials of large g and high mechanical strength.

Applications recently drawing attention include an actuator, where the piezo-electric materials are used as a displacement device for their electric/mechanical energy conversion characteristic. This is widely expected to be used in fields where very small but highly accurate and fast-speed displacement is required, such as for ink-jet printer, wire-dot printer, relay, magnetic head trucking, and positioning of precision machines. Also, studies are underway to develop this further to build motors. Materials applied to them require large piezoelectric d constant and small hysterisis. Figure 4 shows one example of displacement characteristic of the actuator.

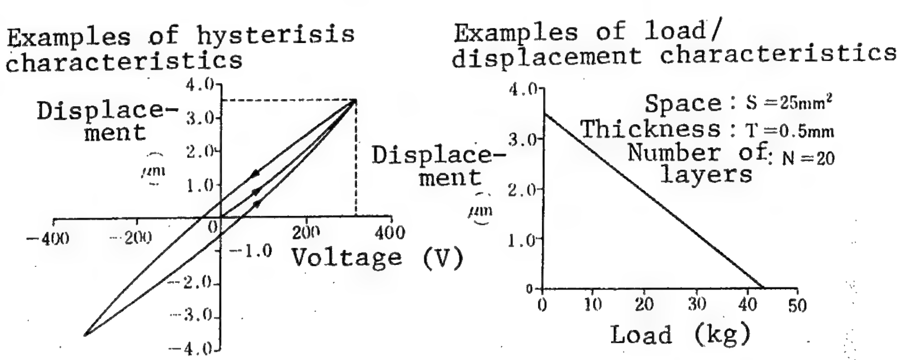


Figure 4. Characteristics of Actuator (layered type manufactured by Murata)

9. Future Development

Following are considered possible future developments of piezoelectric ceramics:

1) Flexible materials by combining with high polymer compounds
2) Materials as stable as single crystals
3) Transparent piezoelectric ceramics

10. Conclusion

Outlined above are piezoelectric ceramics and their applications. As materials which can convert electric energy and mechanical energy efficiently and economically, piezoelectric ceramics will have increasingly diverse application fields and new materials will be developed accordingly.

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NEW MATERIALS

CERAMICS STRATEGY OF ASAHI GLASS REPORTED

Tokyo NIKKO MATERIAL in Japanese Apr 85 pp 12-15

[Article by A. Araki: "Systematize the Business To Plow the Market Deeply; Ceramics Strategy of Asahi Glass Co., Ltd."]

[Excerpt] Focus on the Field Where Ceramics Are Indispensable

The fine ceramics business of Asahi Glass, particulaly its engineering ceramics as construction materials, is at the top level in Japan. The scope of the company's ceramics business has been steadily expanding since 1982. The course to date, according to the company's staff officer for this business, Y. Fukatsu, manager of Engineering Ceramics Promotion, "has been a series of trials and errors and will continue to be the same." He is one of those who pushed the fine ceramics business of Asahi Glass substantially forward in the way which can be described as "from miller to baker."

Technical progress the company made during this period is further development of its own on basic technology of "nonpressure sintering method" first utilized in 1980, as contrasted to the conventional sintering/baking "hot-press" method where baking and hardening are done under external physical pressure. This new method, as indicated by its name, bakes and hardens without adding pressure and has made it possible to mass-produce products of complex form or large size for which the hot-press method is not suitable. Following this development, the company developed high purity particulate crystals of silicon nitrite (Si_3N_4) based on "Chemical Vapor Deposition" (CVD), the process introduced by the U.S. firm GTE, to refine the raw material powder, and marketed the product under the name "Ceraroy-N."

In addition, the company has not only established the normal pressure-sintering technique for silicon carbide (SiC) and commercialized its product under the brand name "Ceraroy-C" (called "Royceram" overseas), but also put on sale "Refel," a product of "reaction sintering" introduced by the British company, BNFL. Asahi Glass also has "Rotech," a ceramic product made from the multioxides compound β-cordierite ($2MgO \cdot 2Al_2O_3 \cdot 5SiO_2$) using the "one-piece molding method" developed by the company. Besides these, the company is actively developing new materials by unconventional combinations with zirconium borite (ZrB^2), etc.

Characteristic of Asahi's products is that there are few metal oxides such as alumina, magnesia, and titania, which are considered the booster for today's fine ceramics boom. The reason for this is that when the company entered the fine ceramics market, "We worked with most of the possible elements out of the 92 natural elements and covered all the major oxides, but alumina, for instance, has become too common. Therefore, we selected the field where our character can be established" (manager Fukatsu). The company deals with some of the simple oxides such as zirconia (ZrO) but only as a general high-toughness material and does not intend to have high quality ones. The company's target is the field where ceramics have absolute merit over metals. The company's stance is that the relative merit of volume or relation with the total cost does not warrant commercialization.

Asahi Glass, Carborundum, and General Electric

Using the basic materials thus selected and technologies thus established, Asahi Glass seeks to develop various parts and their materials in conjunction with users and to gradually expand the scope of the business. One hitch in the technological aspect is the threatening patent problem which high technology is destined to face. Asahi Glass filed with the Patent Office in July (1984) an application for examination of the basic patent on the silicon carbide sintering technology. The technology is to sinter ceramics using alumina as auxiliary agent and the product is commercialized as "Ceraroy-C" (Royceram). The patent application was filed in July 1980. The technology is already registered as a patent in the United States, the United Kingdom, France, and Canada, but due to the different patent system, the patent is not established in Japan and West Germany where announcement and registration cannot be done without an examination application.

The company decided to file the examination application at this point in time not only because engineering ceramics have entered the full-fledged industrialization stage but also to protect the patent against the basic patent of U.S. Carborundum--a company with high-level technology in this field--on silicon carbide sintering method (with auxiliary agents of boron and carbon) which is to be announced in Japan shortly.

In the sintering technology of silicon carbide ceramics, both α-SiC (shape of raw material powder is α type) by Carborundum and β-SiC (same of β type) by General Electric use boron and carbon as auxiliary agent, while the Asahi Glass process uses alumina as the agent. The two processes are "fighting for supremacy" in the world. The method used by Carborundum and others is said to be an excellent process in strength and mass productivity. On the other hand, Asahi Glass "Ceraroy-C," although it requires a more difficult sintering technique and is inferior in early-stage shock resistance compared with the former, features strength against continued pressure.

Because the patents by the two parties may conflict on the basic matter, it is unpredictable whether the situation will develop into a full-scale dispute. In order for engineering ceramics to diffuse as future useful new materials, a state of "coexistence and mutual prosperity" of the two parties is essential.

Outcomes of Joint Research and Development

On the other hand, Asahi Glass has steadily expanded its business during this period. What Asahi Glass has done is manufacture and supply parts and materials realized through joint studies with user companies. Representative products include the skid bottom for the walking beam type furnace and the ceramic valve to control hot air for a shaft furnace which were developed through a venture with Nippon Kokan. Both of them take advantage of heat-shock resistance of fine ceramics. The latter is the valve to control hot air sent to a shaft furnace by respective tuyeres. Silicon carbide made by normal pressure sintering is used for the valve plug. This valve withstands air flow of high temperature (900-1,300°C) and high speed (100m/sec or faster), and does not show fatigue over a long period of time, thus establishing high reliability and realizing efficient operation of the shaft furnace. The valve is expected to expand its scope of application by being used to control the flow rate of high temperature gas other than in the shaft furnace and of corrosive gas.

Another development is ceramic parts for the combustion system of industrial gas turbines realized in cooperation with Mitsubishi Heavy Industries, Ltd. Conventionally, super heat-resistant alloys with nickel are used for such parts, but the problem is that these alloys burn or corrode when gas temperature at the entrance is raised to improve heat efficiency. Asahi Glass solved the problem by using highly heat-shock resistant silicon nitrite "Ceraroy-N" to become the first company in Japan that makes high temperature ceramic parts for gas turbines. The company is conducting studies on the application of sintered silicon carbide to raise the temperature of gas turbines and is replacing conventional materials with ceramics for increasing portions of the turbine.

Apart from this, the ceramic Stirling engine which Asahi Glass is working on jointly with Ishikawajima Multipurpose Boiler, a subsidiary of Ishikawajima-Harima Heavy Industries, is drawing attention. This will be discussed later.

Cultivate the Market With Software/Hardware Combination

Asahi Glass, which seems to have had its fine ceramics business on track through the development of the above-mentioned parts and materials, is facing a new challenge. "We wish to see fine ceramics positively used not only by iron manufacturers but also by machine makers and in many other industries, but there still exists a deep-rooted prejudice among users that construction material is represented by metals, thus few companies dare to try ceramics. We will not grow rapidly unless this kind of bias is beaten down," says manager Fukatsu. In other words, in order to sell fine ceramics it is necessary to cause "conceptional renovation" on the part of users.

As an effective means of doing this the company has resorted to the strategy of making machines and equipment of fine ceramics and offering them to relevant users. Using fine ceramics for major parts and assembling machines and equipment by combining such parts and their surrounding materials, the company commercializes the products as systems with software which comes combined with

an operation/control mechanism. The aim is to have the effectiveness of fine ceramics fully exhibited in order to propagate their merits. This compares to "the baker's idea to simultaneously run a restaurant"--to sell not only bread but also steak, soup, salad, and dessert, to let the customers know how to eat bread nicely.

The project has already started. In principle it is based on collaborative research with major users. What is intended is to expand business opportunity through the technology and know-how so far accumulated with such users. Considered as possibilities are assembling the hot air fan with the shaft of hot-air control valve; designing, assembling, and machining the heat exchanger; and the heating acceleration system for iron-making, etc. Some of them are specifically discussed for export based on domestic performance. Since the scope of one business transaction in this area is of large scale, it seems that the Fine Ceramics Division of Asahi Glass will have its sales soar from this year to the next.

Equipped With Adequate Tools

The ceramic Stirling engine is a future objective of the company after completing the various technical development and business diversification stated above. Asahi and Ishikawajima Multipurpose Boiler jointly developed last fall (1984) something close to the commercial model but full-scale commercialization is still far ahead.

The Stirling engine is an external combustion engine which can use many types of fuel and enjoys good reputation for high combustion ratio and low noise. Asahi Glass started study in the fall of 1981, produced the first trial model "TE-1" in 1982, and then the second model "TE-2" to assess the performance of elemental parts and materials as well as to examine durability, heat efficiency, and power of the engine as a whole. The design of the third model made last fall is a change from the former ones aimed to collect data, to one which makes use of the high temperature/pressure resistant characteristic of ceramics. The materials used for the central portion are silicon carbide and β-cordierite; both feature small heat expansion and good shock resistance.

The tube structure is made reverse to the conventional model: the heater is installed inside the concave unit and helium gas is heated across the ceramic wall so that the piston is moved by expansion/contraction of the gas. The design is worked out assuming a stationary engine for industrial use with a capacity (stroke volume) of 1 cylinder of 1,700 cc x 2 = 3,400 cc; maximum power of 100 hp at 1,200 rpm and standard power of 60 hp at 900 rpm. The company plans to conduct studies for the time being on general performance assessment such as raising the temperature of the helium gas up to 1,000°C and the pressure to 150 kg/cm^3, and to compile the results in 2 years.

For any company, the fine ceramics business is a new field with huge potential future opportunity. Asahi Glass possesses not only technology on powder/sintering which the company had cultivated with conventional "fire-brick-old

ceramics" but also substantial technical accumulation in the chemistry area in terms of raw materials. In addition, regarding material evaluation (such as brittleness destruction dynamics) which bears an important role in new material development, the company had cultivated technology/know-how. Thus, Asahi Glass, equipped with all necessary tools, is in an advantageous position. The company's fine ceramics business is intended to make full use of these advantages.

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SCIENCE AND TECHNOLOGY POLICY

PROMOTION OF BASIC TECHNOLOGY RESEARCH DESCRIBED

Basic Technology Research Law

Tokyo KOGYO GIJUTSU in Japanese Jun 85 pp 9-13

[Article by Masanori Suzuki, senior officer for the technology development program of the General Coordination Department, the Agency of Industrial Science and Technology: "Outline of the Basic Technology Research Facilitation Law"]

[Excerpts] 1. Introduction

It is technological innovation that is the driving force of economic growth. None but technological innovation can contribute to speeding up of sophistication of the industrial structure, the creation of new employment opportunity, and the revitalization of international economy.

We are now in the burgeoning phase of a new technological innovation and are obligated to work on its secure growth such that it blooms fully in future and serves the coming generations.

Since December 1983, the Ministry of International Trade and Industry with this concept in mind has been studying in detail policies including discussions with the relevant councils for the development of industrial technologies to be adopted in the coming years. As a result of this, "A Report by the Prospect Research Association for Technology Development" for the intermediate- and long-term strategy involved was brought out in September 1984 by the Prospect Research Association for Technology Development, a private advisory organ to the Industrial Science and Technology Agency Director; further, on August 23 of the same year, an interim report was made by the Project Subcommittee of the General Committee of the Industrial Structure Council on "the Present Status and the Questions Involved for the Technology Development of the Nation's Industry" which was a comprehensive compilation of the survey results, and on November 27 a report was made jointly by the above subcommittee and the Project Subcommittee of the General Committee of the Industrial Technology Council on "The Policies To Be Adopted for the Development of Industrial Technologies."

Table 1. Present States of Expenditure on Research and Development (FY83) (unit : trillion yen)

Type of research / Stage [of research]	Corporations, etc.	Research organization	Universities etc.	Total
Basic research	0.3 (5.7)	0.1 (12.6)	0.5 (54.9)	0.9 (13.8)
Application research	1.0 (22.0)	0.3 (30.9)	0.4 (36.9)	1.7 (25.1)
Development	3.3 (72.3)	0.5 (56.5)	0.1 (8.3)	3.9 (59.7)
Total	4.6 (100.0)	0.9 (100.0)	1.0 (100.0)	6.5 (100.0)

Note 1: In parentheses are given proportions in percent of research costs, by stages of research, for each type of research.

Note 2: Corporations etc., ...corporations and special corporations of the manufacturing industries, etc., with capitals over Y5 million; "research organizations" ....the government, the local autonomous bodies, and private ownership aimed at experimental research and survey research; "universities, etc." .....universities, research organs affiliated with universities, junior college, etc.

Note 3: The expenditure on research above involved exclusively the one for natural science.

Note 4: The column total does not necessarily correspond to the sum of the expenditures of the individual stages because the column total includes expenditures which are not classified with any of the stages above.

Note 5: The row and column totals do not necessarily agree with calculation because figures are rounded.

A consent was reached soon by the government on the new Industrial Technology Development Policy which maximally reflected the results of these studies and which was materialized in the relevant government budget drafts worked out at the end of the year. A bill for the Facilitation of Basic Technology Research, which would constitute the core of the policy for the new industrial technology development, was presented to the parliament on February 15 this year and passed on May 17. The author presents below an outline of the enacted law together with a review of the discussions on the relevant issue made for its preparation since the year before last.

2. Features of the Technology Development in Japan

Technology development in Japan has a number of features:
First, expenditure for research and development in Japan is largely composed of that of private industries. The expenditure of the nation's research and development in FY83 was concerned, (comprising natural science only), the total of Y6.5 trillion was accounted of which expenditures of private corporation, etc., was Y4.6 trillion, research organizations, Y900 billion, and universities, etc., Y1 trillion, with private organizations sharing some 70 percent of the total. The total R&D expenditure is borne by the government and private organs for Y1.4 trillion and Y5.1 trillion, respectively. In comparison with the Western nations, the government share is below any of those for the United States, West Germany, and France.

Secondly, the research of the nation in the basic and application fields is notably inferior to those of the Western nations. A poll made by this ministry indicated that only 0.8 percent of those polled regard Japan as superior to the Western nations with respect to the technology development in basic research, whereas the majority find Japan to be on the same level when it was compared with the Western nations.

This seems to have resulted from the fact that the Japanese Government in the past was able to introduce technologies from abroad with relative ease and hence, private industries, acting on the market principle, concentrated their efforts on various phases of developments.

Thirdly, there is a growing difficulty in introducing technologies from overseas. The number of technologies introduced increased up to 1973. Then the number rapidly declined in 1974 and 1975; and in 1982, about a decade after the peak year, it had yet to regain the peak year level. It is also notable that the number of technologies introduced fails to become commercialized in Japan as compared with those having already been commercialized abroad.

Moreover, some foreigners hold the view that Japanese system of technology development in the past, which has been dependent on imports of technologies almost exclusively, was a luxury and that it may become difficult to continue taking advantage of technology imports in future. It is also notable that there is a rising tendency in the United States to put a curb on the outflow of advanced technologies. Japan now has to go through a situation where the easy way of importing technologies can no longer be relied on.

Table 2. Comparison of the Technological Level Between the Nation and the West

Unit : percent

	Superior	Equal	Inferior
Basic research	0.8	12.4	86.8
Application research	20.8	72.0	7.2
Development	63.5	35.7	0.8

Note: Source is "A Poll on the Industrial Technology Development and Trade Problem" conducted by the International Trade and Industry Ministry; the figures are percentages to the total number responded; the poll comprises 158 manufacturing and other corporations.

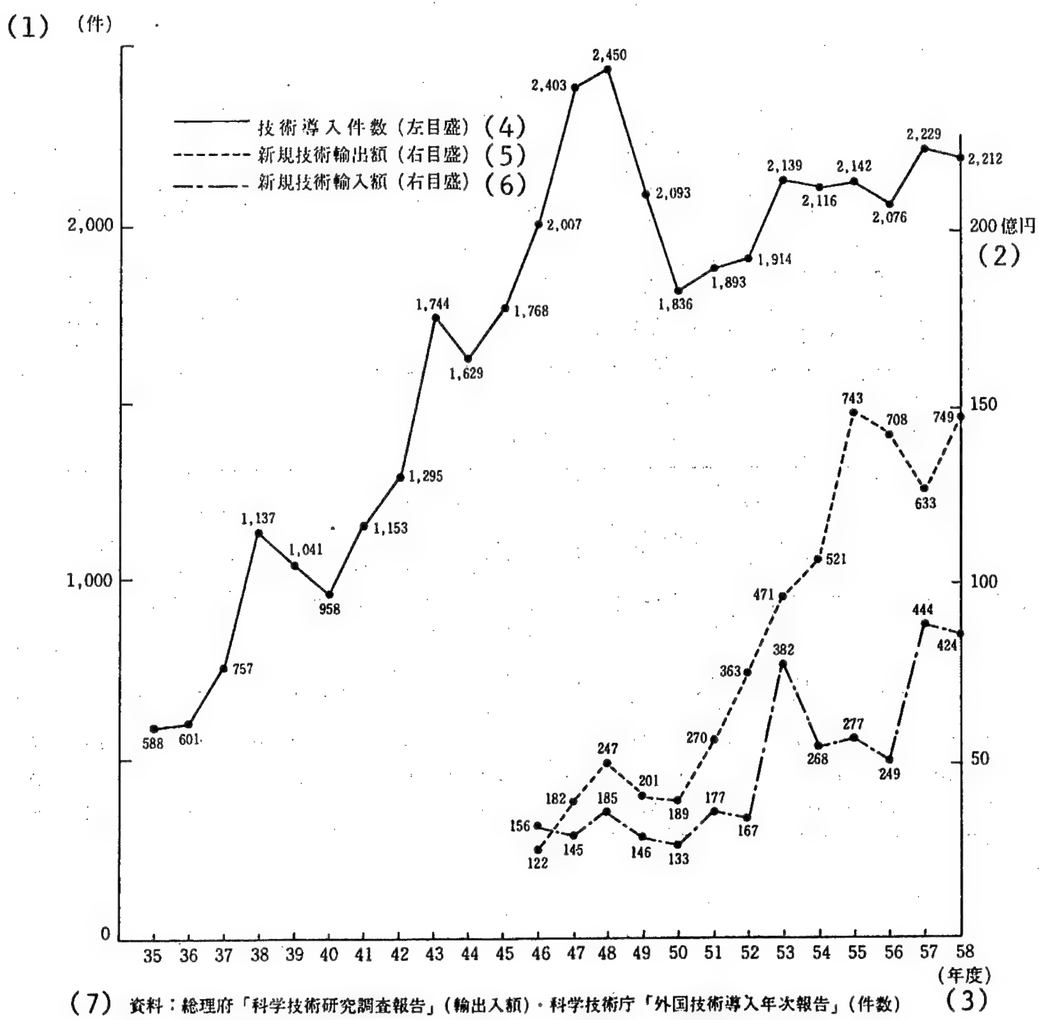


Figure 1. Changes of Technology Introduction

Key:

1. Cases
2. Y100 million
3. Fiscal Showa year--from the Showa year 35 through 58 or from fiscal '60 to fiscal '83.
4. Number of technology introduction (with left-scale calibration)
5. Value of exports of new technologies (with right-side calibration)
6. Value of imports of new technologies (with right-side calibration)
7. Source: "Report on the Survey of Scientific and Technological Research" of the prime minister's office, for values, and "Annual Report on Technology Introduction from Abroad" of the Science and Technology Agency, for cases.

In addition to the changes of the characteristics of technology development and its surrounding conditions, technology itself is undergoing changes toward sophistication and complication. It can be said that major qualitative changes are going to take place. Research in the basic and application fields, therefore, is getting more and more important. [Section 3 omitted]

4. New Policies for Industrial Technology Development

New policies for industrial-technology development must be worked out allowing for the background referred to above. The first job is to provide a clear definition of the role to be played by the government in technology development. Government has had to charge ahead with the assigned role in technology development primarily in the basic and application phases of research in connection with the fundamental or basic technology domains which are of increasing importance.

Some examples of technology developments that the government should push are: Research and Development Project of Basic Technologies for Future Industries, National Research and Development Project (Large-Scale Project), Research and Development on New Energy Technology (Sunshine Project), Research and Development on Energy Conservation Technology (Moonlight Project), and research and development of the 5th generation computer.

The second is to provide for conditions which permit private corporations to display their greatest vitality in order to make more independent and aggressive efforts for technology development since technology development must be promoted largely by the vitality of private corporations.

The third is enhancement of international cooperation by this nation in the domain of research in order to make an active contribution to world technology development in view of the weight of our economy relative to that of the world.

One example is to make more flexible the government regulations on patent rights, etc., which puts an obstacle in the way of international cooperation in research; this must run parallel with the existing multilateral cooperation of, for example, the summit and the International Energy Agency, and bilateral cooperations such as cooperations in research between two nations based on an agreement on scientific and technological cooperation.

5. Enactment of the Basic Technology Research Facilitation Law

The ministry plans to promote a new policy for the development of industrial technology from the year 1985 forward in accordance with the basic concepts given above and the bill for the facilitation of the research on the fundamental technologies presented to the parliament constitutes the core of the new policy. An outline of the law is described below.

(1) Objectives of the Basic Technology Research Facilitation Law

It is of importance in pushing technology development to encourage the technology development of private corporations, which makes up a large part of

that of the nation, and the government hence has to afford favorable conditions for all research involved.

For example, improvements of background conditions for research must be achieved by means of financial and tax policies to make up for economic risks involved in the research, legal provisions for facilitating exchanges of research information, for a testing and assessment system, and for international exchanges of researchers, etc., which private corporations alone cannot afford. Another example is to ease various restrictive regulations such that the research facilities and equipment of the government are made easier more to private corporations, and that researchers of the government are freed from fixed assignments. Still another is a tighter association among industrial, governmental, and academic circles in regard to the technology development involved. The draft bill was worked out faithfully on these basis.

(2) Outline of the Basic Technology Research Facilitation Law

On the basis of the above objectives, the law has two measures mapped out in order to harness the vital power of private corporations.

One is a so-called deregulation or a reaccessment and improvement of the current legal systems involved which make the bottleneck in the technology development by private corporations, as emphasized in not only reports made by the Industrial Structure Council and the Industrial Technology Council but also by the Economic Council.

Another is setting up of a center for the promotion of basic technology research, which supplies to private corporations the risk money, etc., that private financial organizations cannot afford to, and which facilitate joint research based on cooperation among industrial, government, and academic circles. The law, in this connection, characteristically includes an article for the respect of the independence of the center, on the ground that the center should be managed primarily by the creative and ingenious driving force of private corporations and that interventions by the government should be limited to a minimum, if experimental research of private corporations are to be fully promoted. The author does not go into detail for the second measure since this is handled in another chapter of the present article of this journal, and describes the first measure in detail.

One example for the first measure is Article III of the law providing for the availability of government research facilities to private corporations at reduced costs. To be brief, the article concerns those cases where the government allows private corporations to use testing and experimental facilities of the government testing and research organs in connection with research and experiments on the relevant basic technologies, and where the government regards it as necessary to apply an exception of the national finance law in the relevant charges for the use of the facilities, with the view to enhancing the basic technologies in the private industry; in this case, the government is allowed, on the basis of this article, to set the charge level lower than the current one. Testing and research facilities required for carrying out tests and research for basic technologies are

relatively expensive in view of low frequency of its use, and this creates a snag for private corporations in conducting tests and research on basic technologies. The relevant government facilities, meanwhile, have not been easily available to these corporations because of the charges involved which are regulated by the national finance laws, etc. Article III of the law, for this reason, provides for an exceptional measure for the charges involved. The government test and research organs subjected to Article III and rates of charge reduction involved is expected to be given by means of government ordinances, but the prospective organs include test and research institutes of the Industrial Science and Technology Agency and the Radio Research Laboratory, and prospective rate of charge reduction is at a level below some 50 percent.

Another of the examples concerns easing of curbs on patent rights, etc., involved in international joint research. Where international joint research among Western nations are concerned, the contract for practicing the joint research not infrequently includes a provision by which any patent right, if acquired by a member partner as a result of the relevant research, is available, free of charge or at low charge, to persons designated by any partner of the joint research including, of course, the patentee.

In Japan, on the other hand, licensing of the use of a patent right obtained by an international research involves an ordinary charge, which is stipulated by the national finance laws, etc., with no price reductions permitted, and this has not infrequently made the bottleneck in practicing an international joint research.

Article IV of the law provides for lifting of such curbs as an essential means of having the international joint research further promoted and the basic technologies of the nation stepped up. The range of patent rights covered by this article and persons qualified for free or reduced charges for getting the licenses involved are expected to be defined by government ordinances strictly in accordance with the international convention.

In addition to the above two articles, Article V defines the responsibility of the government for taking necessary measures in order to facilitate experimental research of private organizations on the basic technologies and hence to set up their relevant technologies; to quote some representative examples, the government will offer information on its experimental and research facilities by means of public relation bulletins, etc., in order to facilitate their utilization; the government will lift curbs on the use of research results worked out by government commission.

Conclusion

The author has discussed above the outline and the backdrop of the Basic Technology Research Facilitation Law and hopes that experimental research of the private industry will be facilitated in a large measure by the enforcement of this law.

Technology Research Enhancement Center

Tokyo KOGYO GIJUTSU in Japanese Jun 85 pp 13-18

[Article by Akatsuki Okumura, assistant chief of the General Coordination Division of the General Coordination Department, Agency of Industrial Science and Technology: "Outline of the Basic Technology Research Enhancement Center"]

[Text] 1. Introduction

A center for the promotion of basic technology research is expected to start in October this year as a juridical person with the view to promoting the research, by private organs, of the basic technologies.

The center is intended for the tasks of lending help in a comprehensive way to private corporations in connection with technology developments by, among others, supplying risk money to those technology development for which loans and investments by private banks are hardly available and by promoting joint research between a government organ and a private corporation; each task has the common character of providing surrounding conditions favorable for promotion of technology development by private organs.

The center, to be brief, is expected to serve as a comprehensive service organ for the technology development of the private corporations and hence is required, in its management, to exactly understand their demands and to make the best of creative and ingenious efforts of theirs.

The center which does the task of servicing private corporations in this sense needs to be brought up carefully by them such that it functions best.

2. Development

The technology development of the nation, as admitted generally, lags behind that of the Western nations in the basic research phase and application research phase; the consolidation and expansion of the research of these phases, hence, is a requirement of importance not only from the viewpoint of the industrial development of the nation but also from that of the contribution to the world community.

In Japan, meanwhile, private corporations largely bear the brunt of technology development, and their unparalleled capacity for research in the developmental phase, technologies for commercialization of products, and technologies for quality control, among others, supersede those of other nations much that they even make a major contributing factor in the trade friction; it is said, nevertheless, that built-up research results of the basic phase among private corporations are greatly inferior to those of the West and it has become a necessity for them to tackle aggressively research of the basic and application phases in the coming years.

In response to voices raised from various quarters for providing better surrounding conditions for the research of relevant corporations in these phases, including supplies of risk money, in order to facilitate corporation's

effort involved, the ministry made a budgetary request last summer to set up a center which comprehensively carried out the task for the promotion of technology development in private industry such as making loans and investments, promotion of joint research, and supply of research information.

The ministry initially intended to find the relevant source of revenue in the investments and enterprise subsidies from the government's general account as well as in the investment by the Japan Development Bank, and made the relevant budgetary request in the name of an Organ for the Promotion of Industrial Technology Development and later in the name of an Industrial Technology Center.

It was finally decided, however, on the basis of a conference held on 21 December 1984, that the project start in the name of the Basic Technology Research Enhancement Center which combines the original project of the ministry with a plan for an Electric Communication Promotion Organization. A budgetary request was being made by the Postal Service Ministry that the center be set up on the financial basis of loans and investments from the Industrial Investment Special Account of the government, which were to be included in the current budget bill of the government.

Meanwhile, a bill for the Facilitation of Basic Technology Research was worked out by this ministry together with the Postal Service Ministry in order to provide legal basis for the establishment of the center and has been passed by the Parliament recently.

3. Characteristics, Organization of the Center

(1) Legal Person Specially Approved

The center is not a legal person of special status which is set up exclusively by the government but a legal person specially approved which is set up by civilian initiative and of which the number is limited because of the requirement of government approval.

The reason for the choice of the latter is that the center is a corporation for the enhancement of civilian technology development and that, hence, it is desirable to have it managed by making the best of civilian creativity and ingenuity and it is appropriate to have it set up and managed by a civilian initiative. The status of specially approved legal person is also appropriate in that the government has to make uninterrupted investments on the center and hence to give special guidance and supervision to the extent necessary.

It is expected that, with the relevant law having come into force, a group of over 15 scholars and experienced persons of private industry acts as a promoter, and after preparing required documents of, among others, articles of association and planning of enterprise so as to fulfill provisions of the law, an application is filed with the International Trade and Industry Ministry and Postal Service Ministry for the approval of the establishment of a relevant center.

(2) Organization and Management

The staff of the center is made up of a chairman, a director of the executive board, a vice director, and four or fewer members of the same board, and two or fewer auditors. The staff members may include part-time workers. Each member bears a responsibility of his own in connection with the supervision and management of the center and shares the duty and privilege as provided by Article 22 of the law.

A board of trustees is set up for the center as an advisory organ. The board of trustees is made up of not more than 20 scholars and experienced persons. It discusses important matters in connection with the management of the center. The above matters involve among other things: a change of the articles of association of the center; the preparation and a change of the procedures of the office work; the preparation of a budget, a business planning and a funds planning for every business year; and the preparation of a financial statement for every business year.

The board of trustees discusses the problems involved from an unbiased standpoint in order to help the center manage its work unbiasedly, fairly, and appropriately; the chairman and other members of the executive board of the center, therefore, are obligated to carry out its management allowing for the advise of the board of trustees.

There is no special legal limitations for the business system of the center, which is expected to be discussed and decided practically in future as part of the problem of setting up a center, with the coordination of office work processes duely allowed for. Allowing for the quantity of business work to deal with initially, it must comprise, roughly, an investment business section, a loan business section, miscellaneous section (promotion of joint research, etc.), and, in addition, a section for general affairs.

The employes of the center must include those dispated from financial organs and national test and research organs because the center requires persons with a knowledge in finance and persons with a high degree of technological knowledge.

4. Outline of the Funds Involved

The financial basis for setting up a center and the flow of business funds after the center is set up is given in Figure 1. The source of revenue for FY 1985 includes Y12 billion as the basic properties which is expected to be made up of an investment of Y6 billion from the special account of the government for industrial investment, an investment of Y3 billion from the Japan Development Bank, and an investment of Y3 billion from private corporations. It also includes an investment of Y2 billion and a loan of Y2 billion, totaling Y4 billion, from the above special account as the business funds for loans and investments. Dividends of the stocks of the New Telephone and Telegraph Corporation held by the government--one-third of the capital--enter into the above special account from FY 1986 on, and are made use of for the relevant technology development.

5. Outline of the Business Involved

The center engages itself in the following business:

(1) Loan Business--Loans with No Obligation for Interest Under Certain Conditions

The loan business involved as well as an investment business to be described below aims to supply risk money which is needed for civilian technology developments and which is expected to be fully utilized by private corporations for their technology developments.

The loan business provides loans in connection with requisite funds for carrying out a project of technology development which, primarily, starts from the phase of application research. The loan involves no obligation of interest payment in case the effort of technology development fails, but requires a possible 71 percent of interest otherwise. The center aims to provide corporations with a hedge against risk for any failure of the relevant developmental efforts by this measure. The compound interest method is not resorted to, in case interest has to be paid, with the interest rate subject to change with varying financial conditions. It may also be necessary in future to allow for a sliding rate of interest which varies with the extent of success of the relevant technology development. The period of loans involved is expected to be less than 15 years including less than 5 years of unredeemable period.

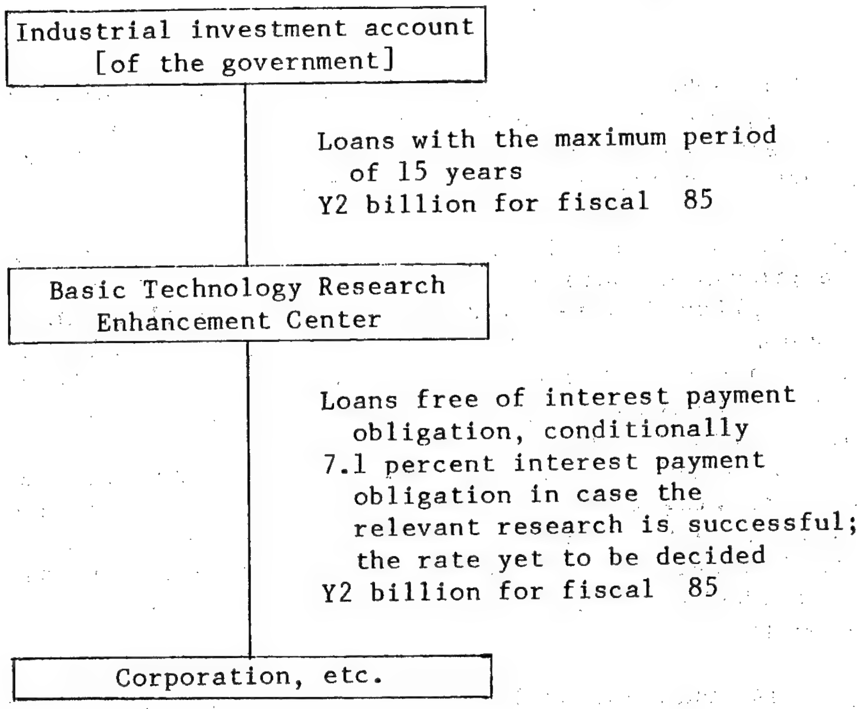
Partly owing to its business period covering only half a year, FY 1985 has the relevant loan funds limited to Y2 billion, and hence the possibility of a shortfall; it would be necessary to increase the fund vigorously as required in the future. The corporations qualified for the above loans are primarily private legal persons in the form of the joint stock corporation.

(2) Investment Business

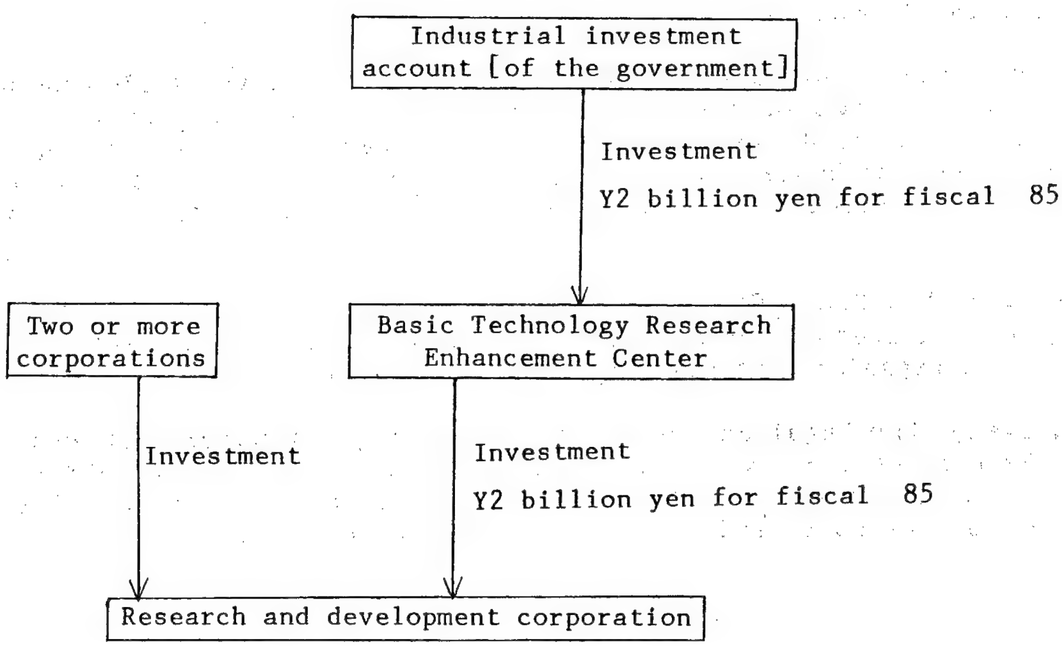
The center makes investments annually as required on the following projects carried out by two or more corporations: (a) project for a technology development carried out from the phase of basic research or application research; and (b) basic and innovative projects which involve many elements for technology development and serves public purposes but have a long lead time.

The size of the funds for this investment is Y2 billion for FY 1985; it is hoped, as described in the section of the loan business, that the quantity of the size be expanded vigorously in future as needed.

Exclusively, the legal persons in the form of joint stock corporations are eligible for the above investment; a corporation that is not of the capital investment type such as a foundation legal person is not qualified. The relevant investment is made through acquisition of the share.



[Figure a]



[Figure b]

"The research and development corporation" must be a newly set-up one if it is to be eligible; legal persons for promoting "New Media Community" and "Teletopia Community" are also eligible.

(3) Promotion of Joint Research

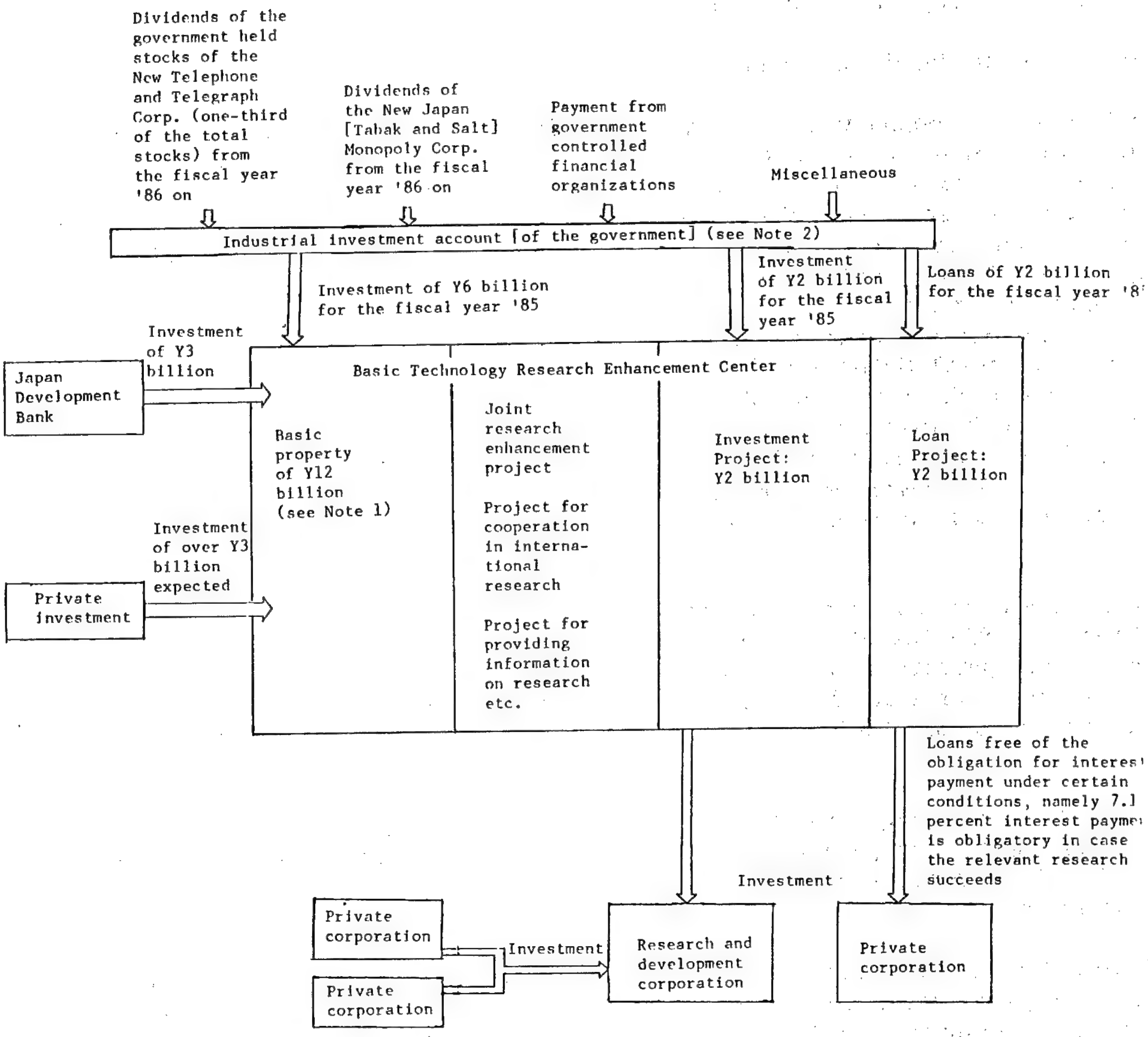
It has become unnecessary to say that cooperation of the industry, academic circles, and government organs plays a major role in the promotion of technology development and, in particular, in the high technology areas and boundary areas of science. This section of the center is aimed at promotion of experiments and research on the basic technologies through consolidation and expansion of cooperation among industry, academic circles, and government organs, and is, practically, assigned the role of mediating joint research among a government research organ and private corporations. With this view in mind, the Industrial Science and Technology Agency is setting up a "System for the Joint Research Combining the Potentials of the Government and Private Research Organs" which provides for a government appropriation for the relevant funds needed and for the admission of researchers of private organizations into government research organs and which makes it possible for the government and private research organs to strive in unison for relevant research.

Practical items for which the mediation of the center are available are:
Collection and offering of information on the research-related matters of both government and private research organs required for working out a project of joint research: for example, information on researchers, research facilities, research subjects and their details; related articles; suggested subjects of research.

Planning of joint project--By making use of built-up information, joint research projects are planned and suggested to those involved. Necessary information is offered and suitable partners introduced to those applying for joint research.

Execution, for the applicants, of various procedures involved in making a contract for joint research--Mediations are made for each partner of a joint research in connection with sharing of researchers, research costs, and research facilities for joint research as well as in connection with patent rights, etc., obtained as a result of the joint research. Various procedures and chores arising in the course of the joint research are executed by this section for each partner of the relevant research.

A diagram for "The System of Joint Research Combining the Potential of Private and Governmental Research Organs is in the Figure [2] for reference.



Note 1: Profit gained by management of the basic property is allotted to the cost for the management of the center and for the joint research enhancement project, among others.

Note 2: Outline of the industrial investment account [of the government] for the fiscal year '85 in Y100 million.

Revenue		Expenditure	
Payment to the national treasury	276	Investment	294
Surplus of the preceding fiscal year	258	Loans	20
Miscellaneous	52	Transfer to the general account	260
		Miscellaneous	12
Total	586	Total	586

Figure 1. Flow of Funds in Connection with the Basic Technology Research Enhancement Center

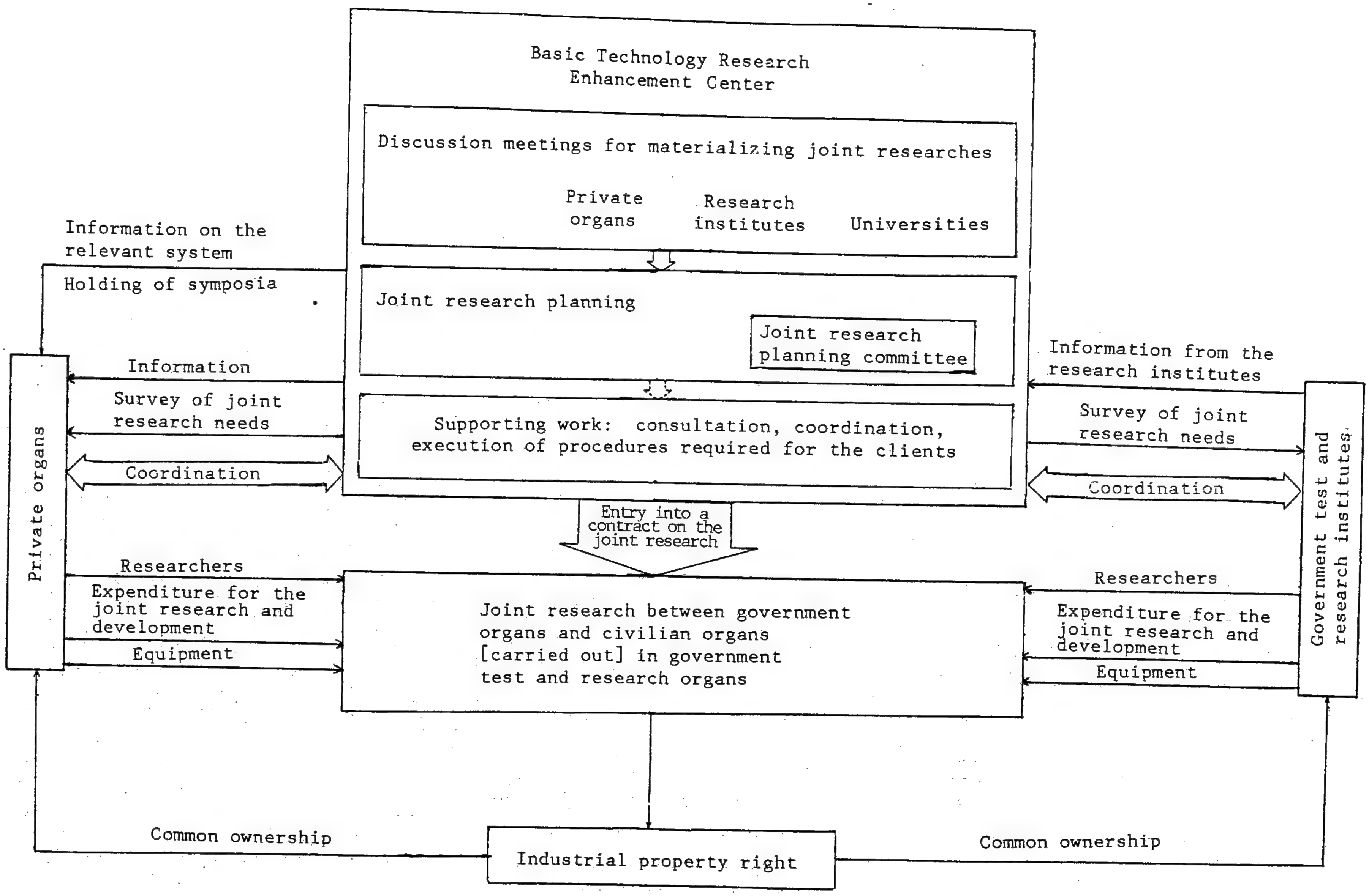


Figure 2. Diagram of the System for the Joint Research Between the Government Organs and the Private Organs and the Role of the Basic Technology Research Enhancement Center Involved

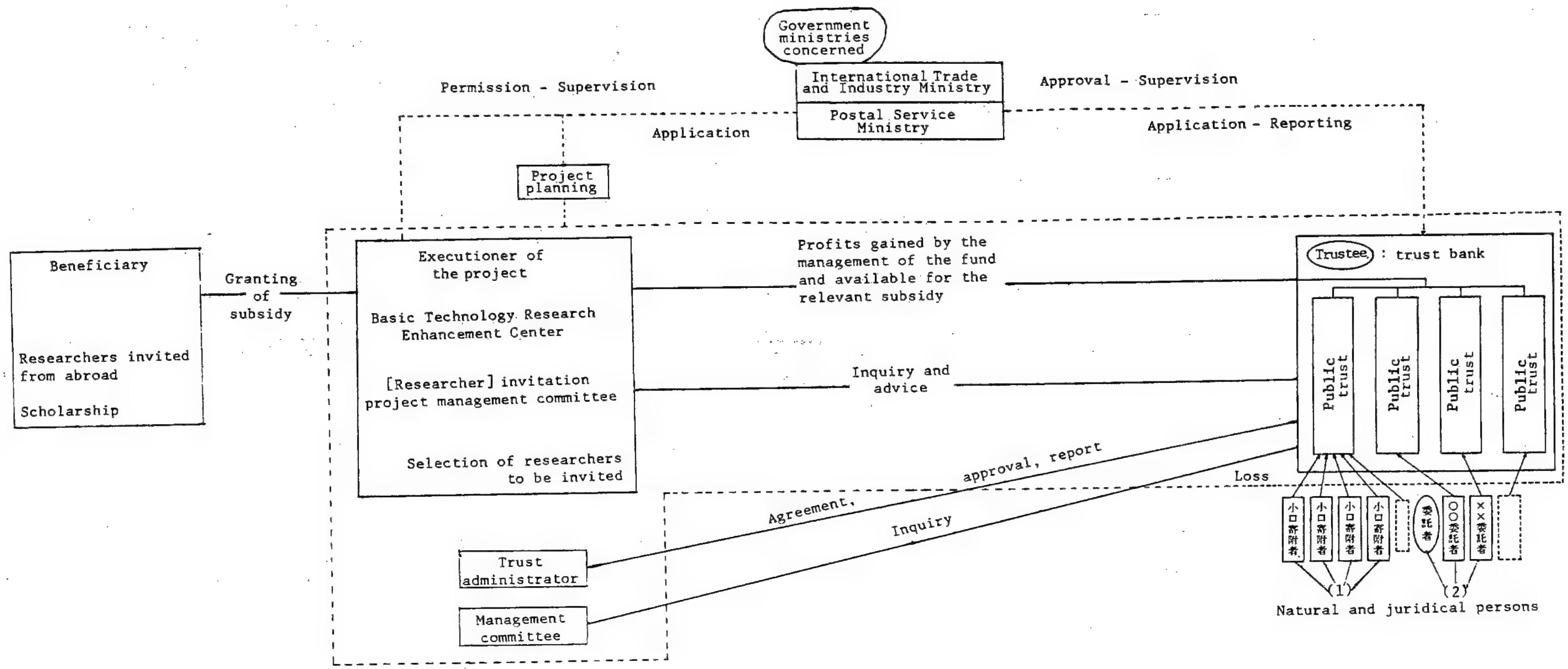


Figure 3. Diagram of the Structure of the Japan Trust Enterprise for International Cooperation

Key:

1. Donor of small amounts
2. Trustee

(4) Experimental and Research Work by Joint Efforts of the Industry, Academic Circles, and Government Research Organs

A private corporation which is prevented from embarking on some experiment and research because of a lack of ability for the relevant research and development, though the corporation is in need of the technology and has enough funds for its development, may entrust the relevant research to the center and this, in turn, invites researchers from private organs and government research organs and allows them to work on it in close cooperation of the industry, academic circles, and government research organs.

The subject of the research involved should be related to the basic technologies and require help of government research organs for facile execution of the research.

(5) Inviting Researchers from Abroad

An enterprise for inviting researchers from abroad, namely, a Japan Trust Enterprise for International Research Cooperation, is set up by making use of a fund collected widely from civilian volunteers (both natural and legal persons) on the basis of the charitable trust system, in order to carry out the work involved.

The invitation of researchers involved is intended directly to enhance the experiment and research of the basic technology of Japan, not just to promote friendship or exchanges of culture. Nevertheless, Japan is obligated to make itself a site of experimental research open to every nation, which also represents a return present to the Western nations which have been inviting our researchers.

This undertaking comprises primarily the following tasks: selection of researchers to be invited; negotiation with and coordination for organs providing lodgings to the researchers; rendering of subsidies to the invited researchers; mapping out of a project involving all items mentioned above, among others. The invited researchers engage themselves in research in corporations, etc., for a period of, in principle, one year.

(6) Supply of Information on Research

The specialized information on research required for the experimental research of private corporations is collected, coordinated with each other, and offered to them. The activity of this section, for the present, is limited to numerical data on experimental research held by the government research organs which are expected to be collected, coordinated with each other, and offered to the public in general as information on research facts.

For FY 1985, information on research facts held by the Industrial Science and Technology Agency including data on chemical compounds will begin to be offered and, besides, information on other issues will be surveyed, preparation of data-bases from them studied, and seminars be held.

(7) Survey Outcomes Available

With the view to enhancing experimental research for the basic technologies, surveys are made and the outcomes offered widely to the public in general. For fiscal 1985, the surveys likely to be carried out include one related to the testing and assessment of new materials such as trends for the relevant technologies at home and abroad, real conditions of the testing and assessment organizations in the Western nations, appropriate methods of testing and assessment, and desirable forms of testing and assessment systems.

Cooperation in Research

Tokyo KOGYO GIJUTSU in Japanese Jun 85 pp 19-21

[Article by Akira Tazaki, professor of the Physical Engineering Department, Tsukuba University: "Possibility of Cooperation in Research Among the Industry, Academic Circles, and the Government Organs in the Academic City Tsukuba"]

[Text] 1. Is Cooperation in Research Among Industry, Academic Circles, and Government Research Organs Necessary?

The other day the author had an opportunity to attend a conference on the cooperation among the industry, academic circles, and the government research organs held at the Institute for Efficiency. With 25 persons of the above three sectors present, an active discussion was carried out on three occasions. Though the free discussion at the conference was apt to get out of hand, we agreed on the necessity of cooperation among the above three research sectors.

It is a matter of course that the nation has to strive in unison to develop new technologies, allowing for the fact that the nation, with scarce land and resources, has to rely exclusively on science and technology for future "life" or existence. It is also a well-known fact that the nation, which aims at a "technology nation" for survival, now finds introduction of technologies from abroad getting increasingly, though gradually, difficult, and that the nation, hence, has to develop new technologies on its own. This is due to foreign nations getting more wary of this nation which has had its technology advanced rapidly. The nation, which has to depend on new technologies and new products from them for "survival," has to make development of new technologies more efficient by substantiating the cooperation of the above three research sectors and, thereby, promoting the efficiency of research of the entire nation.

Along with this active viewpoint, criticism of the present status of the three sectors was also voiced at the conference: briefly, academic circles are shutting themselves up in the "ivory tower" avoiding contact with the outsiders; the government research organs are doing work at low efficiency; and private corporations are in hot pursuit of only immediate gains. Others argued that it is too optimistic to expect to have new technologies developed by mere cooperation of the three research sectors since a discovery or an invention owes much to the genius of individual persons, and that the nation

therefore should set up, first of all, an educational system whereby such genius can grow. These criticisms, in a sense, are to the point and we need to work out measures which can comply with these critical views.

Now let us proceed practically with the issue involved. It is, of course, the industry that uses new technologies to produce new merchandise; the industry, nevertheless, has not much to spare to bring up the burgeoning technology for long and, hence, the need for the cooperation of the three research sectors: the government research organs and academic circles take on the role of bringing up burgeoning technologies whereas the industry take over the technology to find applications. In reality, however, there is no motive for the government research organs and academic circles to render cooperation to the industry. On the contrary, the government research organs are prohibited from rendering aid to individual corporations and some in academic circles regard cooperation between itself and the industry as an evil, which may partly be due to the past student riots on university campuses.

The industry, meanwhile, has to be subjected to various restrictions of laws if it is to obtain cooperation from the other two sectors, in spite of it having to be essentially free, and hence has to run the risk of parting with its own vitality. If the cooperation among the three research sectors is to work effectively, therefore, legal restrictions which do not adapt themselves to relevant development and research must be lifted such that a system in which the government research organs and academic circles can cooperate with the industry, and legislations by which the researchers of the former two sectors are encouraged to work may be provided . This is a rough outline of our conclusion.

In the town of Tsukuba, we have a collection of government research institutes, so a corresponding collection of industrial organizations must be set up here if any relevant cooperation is to be seen in this town. The author presents an example below.

2. Practical Example -- the Tsukuba Research Consortium

Seven years have passed since I was transferred from Osaka University to the present one. Soon after I moved, I had a factory in the neighborhood of the town make components of an apparatus, but the components they furnished are deformed by soldering and hardly available for my research. I was obliged to order them from Tokyo, Osaka, and other places, causing troubles to the office of the university. I keenly realized from this experience how important for research is the surrounding industries. Meanwhile, I happened to visit the High-Energy Physics Research Institute, in the company of Genya Chiba, director of the Exploratory Research for Advanced Technologies, Chikara Hayashi, president of Japan Vacuum Technology Corp., and Teruo Hiruma, president of Hamamatsu Photonics Corp. Both corporations accepted orders of the institute for some apparatuses. The orders, however, involve fabrication of special products which require repeated trial manufactures, and the Hamamatsu Photonics, in particular, had to make repeated shuttles between Hamamatsu and Tsukuba. I then strongly advised them to set up laboratories at Tsuka though not from the national point of view but just from the necessity of surrounding industries for research in Tsukuba.

Later on, partly by virtue of the political influence of the above Chiba, a plan was being forged to set up an allied research organ by inviting corporations of intermediate size which had excellent technologies of their own and were once associated with the Research Development Corp. of Japan. While playing golf in Tsukuba's clubs, the author persuaded presidents of various corporations to join in the plan of a research consortium. The objective of the consortium was for the government research organs and academic circles to have their research sites directly connected with supporting industries and for the industry to get information on the research of the other two research sectors at an early stage and acquire some of the technologies involved therein for development and commercialization on its own. In addition, private corporations may let the other two research sectors understand problems currently confronting them by exchanges of persons, thereby influencing the choice of the next research subjects by the other two sectors; this we call the "seed sowing" mechanism. The function referred to earlier, on the other hand, may be called the mechanism of obtaining seedlings and bring them up.

The consortium, in terms of software, is centered at exchanges of persons as can be seen from above. In terms of hardware, it also concerns itself with providing places where people like to gather; the director Chiba suggested that, whether in the East or the West, people like to gather at places like the temple, where they take meals in the living quarters and then hold conversations in the courtyard. In the meantime, a plan for developing a park for a group of laboratories at Tokodai, or a "research park" to the west of the academic city Tsukuba, happened to be materializing, and we immediately made a contract for a piece of land there.

Corporations joining the park early were Akashi Manufacturing Corp., Stanley Electric Corp., Tokyo Applied Chemistry Industry Corp., Japan Heavy Chemistry Industry Corp., Japan Vacuum Technology Corp., and Hamamatsu Photonics Corp., and, a little later, Teisan Corp. and Yasukawa Electric Manufacturing Corp. With a plan for managing the consortium as a public service corporation being defeated because of extreme difficulties involved presently in getting government approval, they had the consortium starting as a joint stock corporation.

With the consortium starting, the role of its originators, the author and the director Chiba came close to the end and researchers from every corporation joined were embarking on their projects steadfastly. The key to success at this juncture was finding a greate bonze--since the consortium is like a temple according to Chiba's plan--who can attract people only by seating himself therein. The author and the director Chiba selected Tetsuzo Kawamoto, then director of the Research Exchange Center of the Science and Technology Agency as the only man for the job, and, after a long period of persuasion, succeeded in having him accept the job.

The laboratories of the Japan Vacuum Technology, the Teisan, the Stanley Electric and the Hamamatsu Photonics have to date been built in the vicinity of the headquarters of the consortium, and the traffic of young researchers there was getting heavier. Among the main activities involved are: touring

through government research organs for the study of observation by researchers of corporations, lectures at the consortium given by invited researchers, and joint surveys carried out by young researchers of corporations, among other things. The restaurant which was included in the original plan has yet to be in full-fledged operation because the number of researchers living in the town Tsukuba is still limited. A full-fledged operation is expected to come after all of the laboratories of the private corporations have been completed.

3. Reality in the Exchange of Research Among Industry, Academic Circles, and Government Research Organs

As described above, the government research organs and academic circles both cooperated in the setting-up of the Tsukuba Research Consortium so far as the planning of the project was concerned. Once a core system is formed and operating, the driving force of private corporations are intensive enough to have the operation going on. Cooperation from the government research organs and academic circles in this active phase of the undertaking, nevertheless, is strictly limited by laws. It is true that the government official should not be concerned in the business of private concerns, but present laws that make the rendering of research cooperation nearly impossible in reality. In the government financed universities under the administration of the Education Ministry, any work carried out outside of the government organs is called a side job, which requires approval of the education minister and is limited to 7 hours per week regardless of the content of the work. This limitation imposes a restriction on any cooperation rendered to outside works even if it is a national project.

It is conceivable that a university professor working outside the range of the government organs may tend to neglect his duty of education; however, from the standpoint of the cooperation that is required among the three research sectors involved of the nation, this regulation exerts an adverse effect. Though the author has not the exact knowledge of the government research organs, it seems that the same restrictions prevail there as in universities.

Joining universities in the relevant cooperative efforts in research of the nation works to advantage also in terms of education. In sections where the educational staff are working briskly by keeping contact with organs outside of the university, students also become more active. In the engineering department, in particular, research sections which lack contact with organs outside seem to have less vitality. As for the research section of the author, for example, corporations are dispatching researchers to his section and thus contact with the industry is maintained even in the present legal system; in this sense, the author needs to have no worry for being segregated from the industry.

It may be concluded from above that cooperation in research among the three relevant sectors is extremely restricted largely owing to legal limitations. Except for education at the university campus, cooperation that can be rendered to the industry by university is limited to just offering ideas, answering questions, giving lectures, etc. The nation, nevertheless, requires a legal system which makes the cooperation in research among the relevant three sectors possible, if the cooperation is of significance to the nation's

future at all. If men of ability working in research at government research organs and in academic circles are to serve the future of the nation, a legal system must be set up by the concerted effort of the people at large, a system wherein the researcher absorb himself in research in an allied team of the industry, academic circles, and the government research organs. The author, at the conclusion of this brief article, hopes that his viewpoint will be sympathized with by many of the readers.

Enhancement of Cooperation

Tokyo KOGYO GIJUTSU in Japanese Jun 85 pp 21-24

[Article by Technology Research and Information Division of the General Coordination Department, Agency of Industrial Science and Technology: "Enhancement of Effective Cooperation Among Industry, Academic Circles, and Government Research Organs--A Report from the Ishizaka Research Association"]

[Text] The necessity for a more comprehensive discussion was pointed up in connection with the measures for pushing ahead practically the cooperation in the enhancement of technology development among the three research sectors--industry, academic circles, and government research organs--which were described in "A Report by the Prospect Research Association for Technology Development" released by the Industrial Science and Technology Agency in September 1984. The relevant discussion therefore, was continued by setting up a research association chaired by Seiichi Ishizaka, a consultant of the Nomura General Research Institute, and the results in a concise form are presented in this article.

The necessity for a cooperation among the relevant three research sectors has long been argued, but it has not generally been felt that successful results in research have been brought out in succession by virtue of the cooperation among them. The dominant view must rather be that, even in the present state, the cooperation among the relevant three sectors in research of the nation is not satisfactory in various aspects. There may have been no surrounding conditions in the postwar period of Japan or at least till the end of the era of economic high growth for the relevant three sectors of researchers and technicians to have to push ahead a research subject in cooperation with the view to creating an innovative technology based on some new principle or concept. Cooperation in research among the three sectors has been rejected by some as something that erodes the autonomy of the university and liberty in research and that leads to an evil connection with particular business concerns.

With the burgeoning period of a technology innovation coming, however, there is no guarantee for the present system of research and attitude toward research and technology development will work well in future as in the past. The generalization that the nation, with over 100 million people having to survive on a few islands with no resources, must be based on production and maintenance of those technologies that are creative and add high value has become generally recognized. In this sense, it would be the present day requirement to work out a new concept and a new national consensus for the enhancement of joint research among the three relevant sectors. On the grounds

that the cooperation in research among the three sectors constitutes a measure for pushing ahead research and technological development with creativity and vitality, decisive methods for the enhancement of the cooperation should be pursued, and an action program be set up which removes one by one those barriers that impede joint research based on free ideas of researchers.

1. Why the Requirement for Cooperation Among the Three Research Sectors?

(1) New Concept

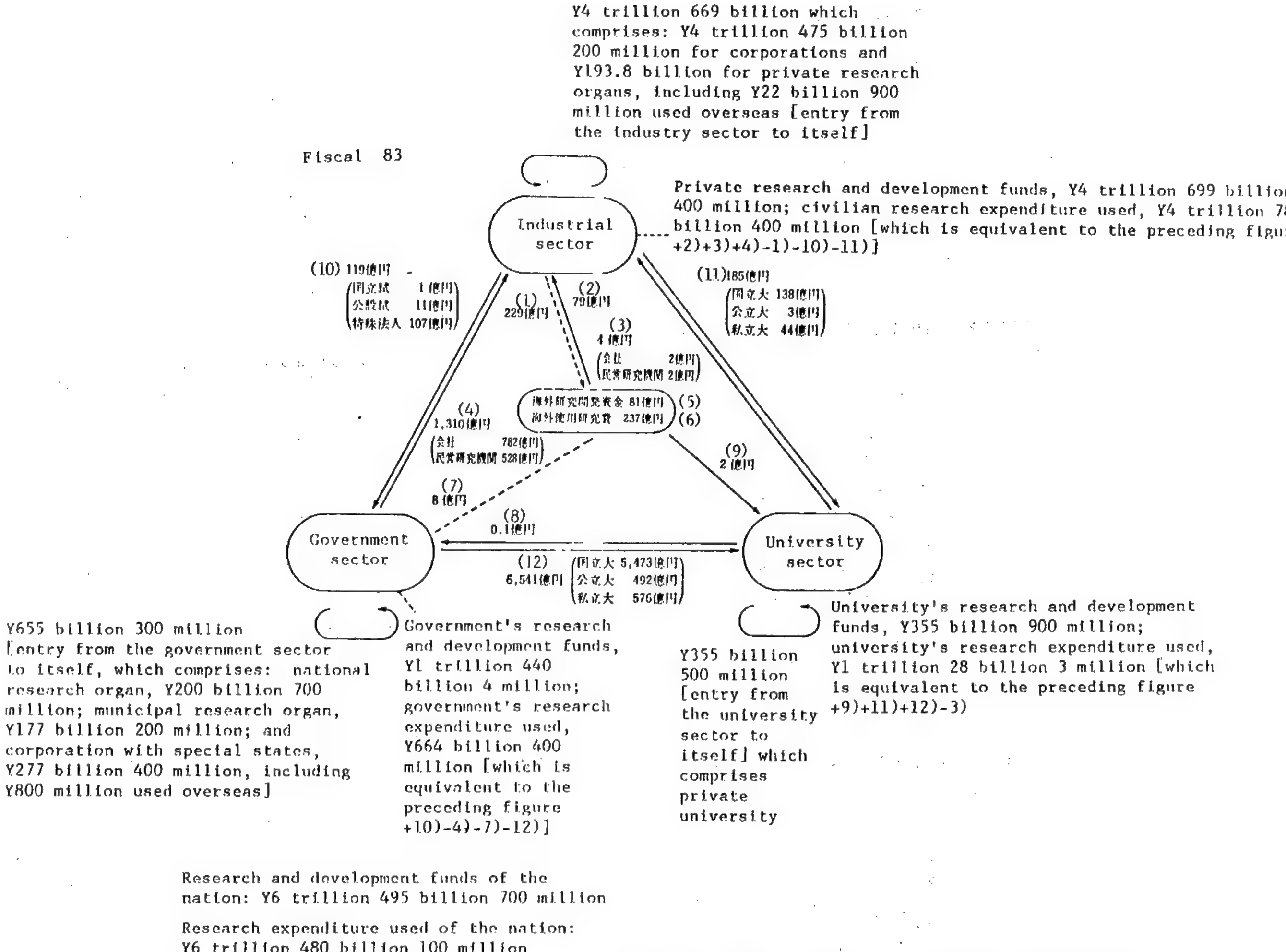
Mutual education, enlightening, exchange of information, etc., among different researchers and technicians constitute an extremely effective causative factor for yielding new notions and concepts. Research and development made by homogeneous researchers and technicians of a specific limited field, on the other hand, is apt to have the research ideas fixed and stunted. It is also sometimes necessary that one change his concept in research and delve into the scientific basis of phenomena and principles if he is to make a technological breakthrough as he explores the unknown areas such as microscopic technologies or composite technologies of today. It is, therefore, necessary to provide for surrounding conditions which afford many opportunities of contact among researchers of the relevant three sectors who have different concepts and different orientations in research and development and to allow them mutual exchanges of views, education, and "brainstorming" in a liberal atmosphere.

(2) Growth of a Concept

Even a brand new concept with rich creative elements cannot crystallize into an innovative technology unless surrounding conditions are provided which understand the potential of the new concept and take care of it. In this process of growth which may be called a burgeoning period before the bloom of an innovative technology, the concept is dressed up with theoretical grounds and scientific backgrounds in the new light of analysis and, concurrently, technological examinations are repeated in connection with its feasibility. This process also represents one of trial-and-error of extreme diversity and, hence, often takes very long periods of time. A concept for research, therefore, grows into a solid technology only if a surrounding condition is provided which permits such kinds of trial-and-error and which is capable of evaluating such a prospect. It seems that what is required at this juncture is an "expert eye" or the judgment of each of the researchers that permits them to pick up an idea of high prospect and to bring it up after exchanges of views with each other on new ideas which are enhanced by, in particular, induced contacts among the relevant three research sectors.

(3) Relationship Between Science and Technology

Once the technology of mechanics to forge out a piston which exactly fits into the cylinder was necessary for the invention of the steam engine; conversely, the development of the theory of electromagnetics in the 19th century led to the invention of the means of electric communication.



Source: "Report on the Survey of the Scientific and Technological Research for the Fiscal Year 83" of the General Affairs Agency

Figure: Diagram of the Flow of the Fund for Research and Development of the Nation--for Reference

Key:

1. Y22 billion 900 million [outflow from the industry]
2. Y7 billion 900 million [as entry to the industry]
3. Y400 million [as entry to the industry]: corporations, Y200 million; private research organs, Y200 million; [as acceptors]
4. Y131 billion [as entry to the industry]: corporations, Y78 billion 200 million; private research organs, Y52 billion 800 million; [as acceptors]
5. Research and development fund overseas of Y8.1 billion
6. Research expenditure overseas of Y23.7 billion
7. Y800 million [outflow from the government]
8. Y10 million [outflow from the university]
9. Y200 million [entry to the university sector]
10. Y11 billion 900 million [as outflow from the industry]: government research institute, Y100 million; municipal research institute, Y1 billion 100 million; corporation with special status, Y10 billion 700 million; [as acceptors]
11. Y18 billion 500 million [outflow from the industry]: national university, Y13 billion 800 million; municipal university, Y300 million; private university, Y4.4 billion; [as acceptors]
12. Y654 billion 100 million which comprises: national university, Y547 billion 300 million; municipal university, Y49 billion 200 million; private university, Y57 billion 600 million [entry to the university sector from the government sector]

As can be seen, science and technology contributed to one another in their development. Recent years, however, have seen their relationship growing far more intimate and both developing just in resonance, exerting to one another a positive effect in the geometrical ratio.

For example, the big sciences such as nuclear fusion and the elementary particles therof would not be able to obtain even the experimental data without the high technologies foremost advanced, and the frontier of biotechnology, in turn, has been opened wide by virtue of the birth of a new science, molecular biology. More recently, it has been pointed out that progress in technology has posed problems to pure sciences and attracted attention of scientists therein, leading to exploration of new scientific domains and hence to progress in science. Enhanced research on the theory of fluid dynamics resulting from the development of aeroplanes, and theoretical research on the Josephson effect speeding up from the requirement for higher speed of computation in integrated circuits, among others, are examples. Under the circumstances, big sciences and high technologies have to be dealt with by concerted efforts of science and technology and, at the same time, a "feed back" or interchange of knowledge between the two fields have to be maintained intimately in order to make the best of the attained results of each by the other.

(4) Composite Research Subjects

The frontier region of recent research and development is characterized also by having an increasing number of subjects of research covering many special fields of science, for example, mechatronics and bioelectronics. The research and development of today in the regions of most advanced high technology has to be dealt with by an "interdisciplinary" system in the true sense of the term, though it is a long time since the term interdisciplinary became available in our vocabulary. As one sees today's science and technology proceeding with specialization into so diverse sectors as, to have no languages common to these sectors, he is not allowed to wait for the appearance of a genius who is versed in all sectors. These composite scientific research subjects cannot be dealt with properly unless one combines all the resources required for research and development, for example, intelligence of researchers of the relevant sectors, experimental and research facilities of the relevant sectors, funds, etc.

2. Effective Cooperation in Research Among the Three Sectors, Industry, Academic Circles, and Government Organs

(1) Removal of Legal Barriers

The problem of most importance in connection with pushing creative research and development is an effective cooperation of the three relevant research sectors effected by combining talents of the three sectors and by allowing free and broad exchanges of their views is the removal of various legal barriers which are preventing free exchanges of able researchers, information, and equipments as well as free flow of funds. To be more precise: a) to facilitate the use, by the private organs, of the facilities of the governmental research and test organs; b) to handle flexibly the patent rights

owned by the government; c) to allow use, at low charge or free of charge, of patent rights, etc., obtained as a result of international cooperation in research; d) to enhance the transfer of researchers of national research institutes and universities.

The Law for the Facilitation of Basic Technology Research passed by the parliament recently provides for the use of government facilities at low charges and more lenient licensing of the use of patented inventions obtained by international joint research, among others, and its effective implementation is expected henceforth. It is also hoped that the Center for the Enhancement of Basic Technology Research to be set up on the basis of the above law be managed in flexible manner and that exceptional measures for the free transfer of the government officials engaged in scientific research be examined aggressively.

If the above center, in particular, is to function effectively, the following two factors must be of importance: a) to set up an assessment system which is capable of judging and selecting a subject of technology development with potential for future success, while the project is still in the burgeoning stage, and of guiding it in technology; b) to set up a management system by experienced persons which is capable of mapping out projects for organic and efficient joint research by combining manpower, facilities, patents and other achievements, funds, and other requirements.

(2) Enhancement of Exchanges of Information

It is important to start exchanges of information among researchers by making public the general state and actual conditions for the progress of research and development with respect to each of the three research sectors, if the exchanges of information among the three sectors are to be enhanced. It would also serve as a major incentive to research and development if a provision is made for the convenience of researchers and technicians of ability both at home and abroad such that they may come together in the same location to exchange views although they come from the three different research sectors of the nation, etc., and have different specialized research areasand differentresearchorientations.

(3) Promoting Cooperation in Research Among the Three Relevant Sectors in Local Districts

Relevant cooperation in research is promoted also in local districts by such organs as local universities, local test and research institutes of the government, test and research institutes of local municipalities, local municipalities, and corporations concerned. The subjects of relevant research are selected and exchanges of information, etc., among different industries carried out depending on the characteristics and actual situation of the district involved, though in a quiet manner, on the basis of the three sector cooperation, and steadfast achievement in terms of technology promotion are expected to come in the coming years. The nation, with the development of creative technologies put up as its supreme target, must have to set up a system with its bases rooted in entire areas of the nation in order to absorb technological "seeds and needs" everywhere.

3. Contribution to the World Required of Japan

Because it was blamed for the surplus in the balance of trade account of the nation blamed for by foreign nations at the Bonn summit last year and on other occasions, the nation is required to carry out stable economic management based on the expansion of its domestic economy and to contribute to the world as suited to its international position. It is a view shared generally that technology is the key to economic activity. The nation also should depend on technology development henceforth for the expansion of its domestic economy, and realize stability in its intermediate- and long-term management of the economy by the enhancement of technology development. Now that the role expected to be played by technology is expanding in connection with the expansion of the frontier of the world economy and for the solution of problems common to humans, the nation rather should call positively for an international cooperation in research and play the role of the coordinator for it. At the same time, the nation needs to become deeply aware that it is required to contribute to the international community by setting up a system of research and development which is liberally open to the nations of the world.

4. Fostering and Making the Most of Able Researchers

The question of the source of creativity boils down, after all, to that of the creativity of individual researchers. Even mutual enlightening of researchers in their cooperative research efforts presupposes the presence of some special qualities of individual researchers such as flexibility in mind to accommodate different ideas and views of others and curiosity by which to take up results of research from other scientific fields. It is necessary in the coming years, therefore, to undertake comprehensive studies on the issue of education which appreciates the quality of researchers and fosters their creativity and on the methods of making the most of able researchers including those with advanced degrees.

Internationalization of Technology Development

Tokyo KOGYO GIJUTSU in Japanese Jun 85 pp 25-30

[Article by Kikei Kawashima, executive and director of the General Technology Division, Mitsui Trading Co., Ltd.: "Methods for Promoting the Internationalization of Technology Development"]

[Excerpts] The nation, with the view to closing the gap in technology between itself and industrially advanced Western nations, introduced their technologies aggressively. With these technologies further improved and advanced and with technologies of its own developed, the nation is now abreast of these nations in the industrial level in all sectors of industry except space, aeronautics, and nuclear power, and even leading the world in many sectors including those of steel making, automobiles, and electronics.

It is true that the technology level of the nation has made a rapid progress, but the nation still is left behind the Western industrially advanced nations in not a few areas of scientific research including those of basic scientific and technological research. The nation with no notable resources, therefore, still has to lay major weight on technology development for its future prosperity.

The fact that the nation has carried out an efficient technology development by introducing advanced technologies and thus achieved a high rate of economic growth, meanwhile, has caused the criticism for the so-called free-ride on technology, a sharp criticism against the nation raised by Western nations. Trade friction, which ranged from automobiles to electric appliances and further to beef and oranges, has been stepped up to "technology friction," posing a problem in the form of standardization in communication equipment. It is no exaggeration to say that the success or failure in internationalization of the high-technology sectors dictates the future of the nation which must base its prosperity on technology.

The pronouncement in the summit joint communique that "the revitalization and growth of the world economy depend on the efficient application of scientific technology and cooperation among nations" also put a major weight on international cooperation in technology; the nation must be fully aware that the nations of the world are watching the moves of this nation's high-technology development with keen concern, and explore the method of internationalization from the international standpoint. Approach to and solution of the problem involved, at this juncture, can vary depending on whether importance is attached to the joint development of high technologies or to the growth of industry and on whether the problem posed is tackled by the initiative of the government or private corporations or by consolidating the cooperation among the private corporations, academic circles, and government research organs.

In pushing joint research with an overseas organ such as a corporation, a university or a research institute, difficulties have often arisen from lack of mutual understanding among the partners and, in particular, from the misunderstanding of the present situation of the partner. The author, therefore, would like to refer first to the policy for the promotion of science and technology of each major nation and its present state of internationalization.

Relevant Trend for the Industry of This Nation

The present state of internationalization in research and development for each major nation was reviewed above briefly. The industry of the nation, meanwhile, is orienting its effort to further consolidation of the activities in international research and development as a management strategy of corporations, according to a recent survey by the Research Institute for the Engineering of Future.

Some of the major outcomes of the survey are:

(1) Where any form of tie-up with industrially advanced Western nations is concerned, 53.5 percent of the 500 manufacturers surveyed are carrying out exchange information, etc. After 5 years, 61.9 percent of them intend to make some tie-up, and joint research is expected to be made by over 50 percent of them.

(2) The tie-up in research and development is being made not only between corporations of the same industry but also between corporations of different

industries, whereas it was once limited to the form type only. After 5 years, an increase is expected in the amount of research commissioned to private research and experiment organs.

(3) Tie-ups with the United States account for over 60 percent of all relevant tie-ups; amounts of many of the relevant investments are around Y50 million per year and tend to increase; periods of research are growing from 1-2 years to 2-3 years; the quality of research is undergoing changes from the research of the developmental phase of 5 years ago to those of the application phase.

(4) The tie-ups with overseas universities and public research organs are aimed at: a) stepping up the level of research potentials of its own by means of acquisition of research know-how, by building up and improving knowledge, and by improving the ability of researchers; b) supplementing, from the partner organ, what a corporation lacks or taking up from the partner any element different in quality in connection with technologies, talents, ideas, and know-how, research equipments and facilities, etc.; c) exploration of creative technological seeds. The tie-up with overseas private enterprises as compared with the tie-up with overseas universities and public organs, on the other hand, is more inclined to pursue direct profits by, for example, speeding up development of products that are adapted to the need of the market.

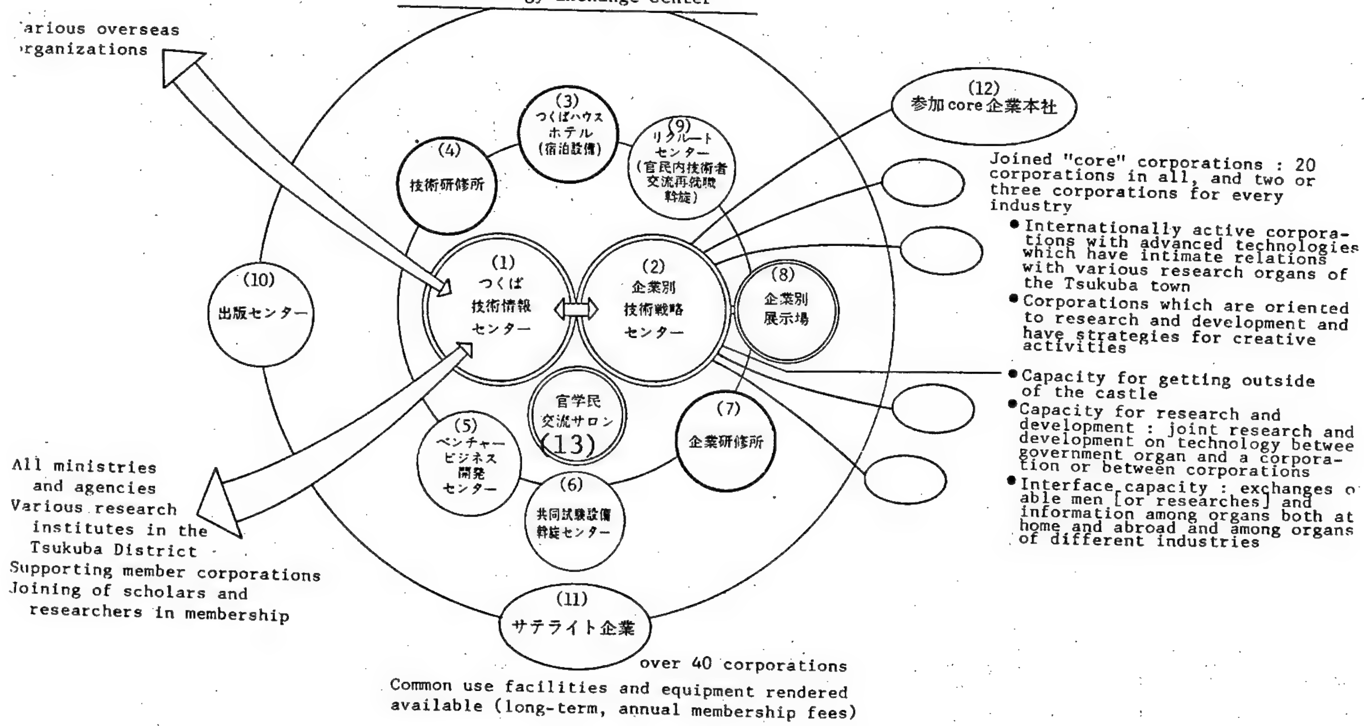
(5) Where the success or failure of relevant tie-up cases is concerned, successful cases are seen in those tie-ups where needs in technological aspects--levels, areas, characteristics, etc.--match one another, and mutual communication works well in the phases of project planning and of project execution. Failures are often encountered when preliminary understanding of the overseas partner in technological aspect is not satisfactory or when the Japanese corporation is not fully prepared for the tie-up, namely, for project planning, for coordination, and for the management involved.

(6) Causes for blocking internationalization and relevant methods of solution are: a) Difficulties in collecting information on the tie-up partner, etc., (44.3 percent) must be dealt with by collection of the information required and reinforcement of selective function. b) Shortfalls of researchers in the Japanese corporation (35.7 percent) must be solved by fostering and securing able researchers. c) Unsatisfactory preparation for the tie-up, namely, for the project planning and for the management (2.5 percent) must be coped with by the consolidation of management. It is no exaggeration to say that the internationalization of private enterprises of the nation is being promoted as part of management strategy by means of setting-up of overseas plants and offices and of overseas outposts for research tie-up in a steadfast fashion.

Road to Internationalization--Improvement Required Also for the Exchanges of Technical Experts

With the enactment of the current Basic Technology Research Facilitation Law, the author is looking forward to further advancement of internationalization such as: more lenient licensing of the use of patents obtained by international joint research and invitation of overseas researchers.

Diagram of a Prospective Tsukuba Technology Exchange Center



Key:

1. Tsukuba technological information center
2. Center of technological strategy for individual corporations
3. Tsukuba house hotel (sleeping accommodations)
4. Technological inservice training institute
5. Venture business development center
6. Service center for the mediation of the use of common experimental facilities
7. Business inservice training center
8. Exhibition hall for individual corporations
9. Recruit center for the exchange and reemployment of researchers among government and private research organs
10. Publication center
11. Satellite corporations
12. Main offices of joined "core" corporations
13. Government-academic-private sector exchange

[Left side view]

Diagram of an Imaginative
Tsukuba Technology Exchange Center

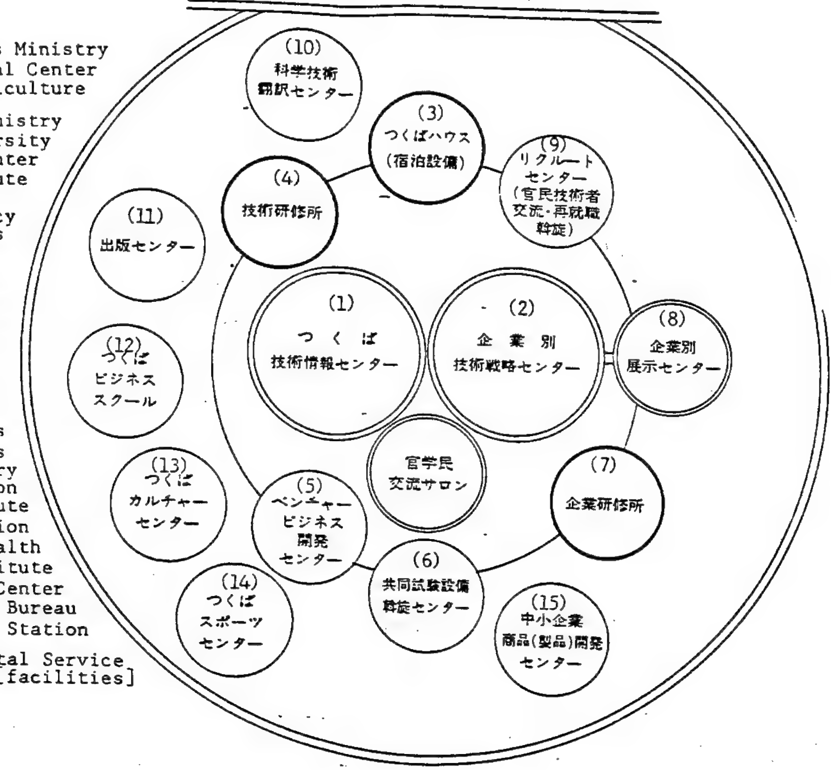
Foreign Affairs Ministry
Tsukuba International Center
International Training Center for Agriculture

Education Ministry
Tsukuba University
Library Information Center
High Energy Physics Research Institute

Science and Technology Agency
National Research Institute for Metals
National Research Center for Disaster Prevention
National Institute for Research in inorganic materials
Tsukuba Space Center
Research Exchange Center
Office of Life Science Experiment of the Institute of Physical and Chemical Science

Ministry of Agriculture, Fishery, and Forestry
Council of Technology for Agriculture, Fishery, and Forestry
National Agricultural Research Center
National Institute of Agrobiological Resources
National Institute of Agroenvironmental Sciences
National Institute of Animal Industry
National Fruit Experiment Station
Agricultural Engineering Research Institute
Sericultural Experiment Station
National Institute of Animal Health
National Food Research Institute
Tropical Agricultural Research Center
Tsukuba Branch Office of the Seedlings Division of the Agricultural Production Bureau
Forestry Experiment Station

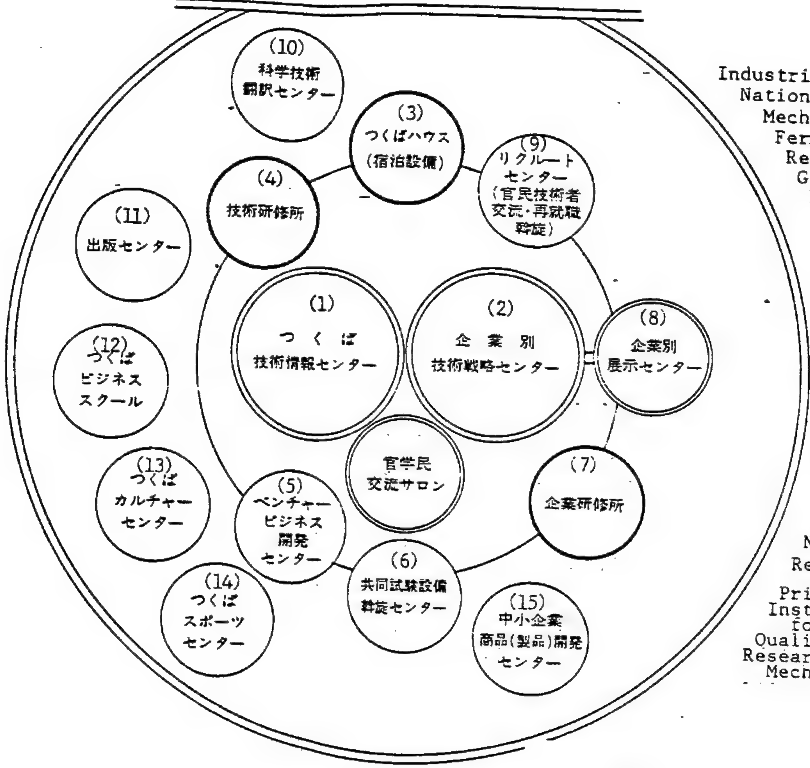
Ministry of Postal Service
Center of Development of Technologies for the construction of electric communication [facilities]



Key:

1. Tsukuba technology and information center
2. Center of the technological strategy for each of the corporations
3. Tsukuba house; lodgings
4. Technological training institute
5. Center for the development of venture business
6. Center for mediating the use of common experimental facilities
7. Business training institute
8. Exhibition center for each of the corporations
9. Recruit center for mediating exchanges and reemployment of researchers of government and private
10. Center for scientific and technological translation
11. Publication center
12. Tsukuba business school
13. Tsukuba cultural center
14. Tsukuba sports center
15. Center for the development of merchandise for small and medium enterprises

Diagram of an Imaginative
Tsukuba Technology Exchange Center



[Right side view]

Industrial Science and Technology Agency of the International Trade and Industry
National Research Laboratory of Meteorology
Mechanical Engineering Laboratory
Fermentation Research Institute
Research Institute of Polymers and Textiles
Geological Survey of Japan
Electronic Technology Laboratory
Industrial Product Research Institute
National Research Institute for Pollution and Resources
National Chemical Laboratory for Industry

Environmental Agency
National Research Institute for Environmental Pollution Research

Transport Ministry
Meterological Research Institute
Aerological Observatory
Meterological Instrument Plant

Construction Ministry
Geographical Survey Institute
Public Work Research Institute
Building Research Institute

Welfare Ministry
National Institute of Health
Research Institute for the Cultivation of Medicinal Herbs

Private research organizations
Institute for the Research of Oceanic Environment and Technology affiliated with the Foundation for the Promotion of Shipbuilding of Japan
Quality Test Laboratory of the Foundation Housing Component Development Center
Research Institute for the Mechanization of Construction Work affiliated with the Construction Mechanization Association of Japan

Key:

1. Tsukuba technology and information center
2. Center of the technological strategy for each of the corporations
3. Tsukuba house; lodgings
4. Technological training institute
5. Center for the development of venture business
6. Center for mediating the use of common experimental facilities
7. Business training institute
8. Exhibition center for each of the corporations
9. Recruit center for mediating exchanges and reemployment of researchers of government and private
10. Center for scientific and technological translation
11. Publication center
12. Tsukuba business school
13. Tsukuba cultural center
14. Tsukuba sports center
15. Center for the development of merchandise for small and medium enterprises

Nevertheless, the acceptance of foreign researchers by this nation is extremely limited and unbalanced compared with the dispatching of researchers from the nation to industrially advanced nations.

For example, the NIH of the United States, where no complex set of laws applies to the acceptance of foreign researchers, sees 180 Japanese researchers engaged in research there whereas the corresponding research institute of this nation has only 15 [foreigners] working in the institute. Another example is found in the Fumbolt Foundation, AVH, of West Germany. In 1983 it accepted from abroad 1200 researchers of which Japanese accounted for 137. The Japanese researchers who have been invited to date to the foundation since it was set up totals 1,030. In contrast, researchers of West Germany so far invited to Japan have been limited to 68 in total.

Invitation of overseas researchers which has been underway for a short time and promoted by the Industrial Science and Technology Agency has made a major impact. Also the Japan Trust enterprise is to start soon amid much hope. It is hoped that enhanced enforcement of these projects, together with founding of an international high technology university, etc., serves to promote exchanges of researchers between this and foreign countries and open the way to internationalization in the literal sense of the term.

Dream Coming True in Internationalization in Research and Cooperation Among Industry, Academic Circles, and Government Organs

A new round of movement for the internationalization in technology development and for the cooperation among industry, academic circles, and government organs has set off. For example, a science park in Britain represents a mode of the cooperation between the industry and academic circles with support rendered by the government and has its origin in the industrial park at Stanford University set up in 1951. The Cambridge science park was set up in 1973 and has now 24 enterprises taking part in it and displaying cooperation among nations as well as among the industry and academic circles -- for example, an effective use of equipment and facilities, computers, and libraries, of the university; exchanges of information by means of personal contacts between the university and a corporation; and interdisciplinary research by participating corporations of different industries.

It is hoped that, in Japan, an organ which serves as an international center of the exchange of technologies be set up at the town of Tsukuba, which has some 40 research institutes functioning therein and which is expected to achieve outcomes in research that can lead the world. It is just a "dream coming true" if a Tsukuba system could be had in the town in future which is comparable to the MIT system, RTP system (Research Triangle Park, North Carolina), or MCC system (Austin, Texas).

Capitalizing on Available Information

Tokyo KOGYO GIJUTSU in Japanese Jun 85 pp 30-35

[Article by Jiro Hiraishi, chief of the Project Department of the National Laboratory for Industry, the Agency of Industrial Science and Technology: "Making the Most of Information on Research -- Spectral Data Rendered Available"]

[Text] 1. Introduction

Computer software, such as data basees and CAD, have been a topic of conversation recently. Opening of the VAN market to private corporations in general since May this year also has been a stimulating factor to this trend. The computer, in chemical technology, plays the role of a computing machine for the computation in, for example, quantum chemistry; it also plays the role of the commander in the technology ranges of automatic control and precision measurement in various instruments and machines. More recently, a CAD system is being developed in which chemical logics are turned into a computer software such that molecules with pharmacological actions, etc., are designed and optimum possible reaction paths to an intended chemical compound worked out. Some systems of the computer, which is capable of designing molecules and reaction paths, and which is imported from the United States, have begun to be made available to the domestic market.

Where research of chemical technology is concerned, needs for data bases are very intense because of the multiple characteristics of diverse substances to be handled. Of the data bases, fact data bases are presently the focus of concern in the relevant sector, along with the CAD systems, where literature data bases including chemical abstracts were primarily dealt with earlier. Building up of data bases is strived for in connection with such fact data bases as the structure of molecules, thermochemical and thermodynamic properties, properties related to chemical engineering including viscosity, and safety or toxicity of substances. Spectral data, meanwhile, has played the role of the pioneer in the activity of building up the fact data base; the reason is that the spectral data has served greatly in the analysis of chemical structure and qualitative and quantitative analysis of organic compounds and that putting in order the spectral data for many of the compounds has been needed in the course of development of petroleum chemistry. The data build-up activity of this nation for spectral data has a long history and for infrared spectral data, in particular, a history of over 25 years.

The project of this National Chemical Laboratory for Industry for building up new data bases included reevaluation of spectral data set out in 1975. The notion that the data base buildup work is not a research then prevailed both in and outside the laboratory, however, as it does at present, often causing troubles. Nevertheless, the author managed to work out the project at long last and to present the outcome to the members of the Industrial Science and Technology Agency in April this year, 10 years after the project began. Though those involved may have not initially foreseen distinctly the rapid progress up to the present level made in the computer, the strong

determination of Dr Shinosuke Saheki, then director of the Basic Chemistry Section, to build up data, which can never fail to survive whatever progress is made in computers and instruments, has acted as the driving force for the researchers of the team. Their steadfast endeavor has led to the completion of the present system SDBS.

It is expected that the importance of information on research will increase in the coming years in a wide range of scientific and technological sectors, not just in chemistry. A data base, made up of information on research centered on fact data and available to many of the researchers with facility, constitutes an important basis to brace up the progress of science and technology. An outline of the SDBS is described below as an example of the fact data bases in the hope that it would serve as a reference in data base related activities in the coming years.

2. Feature of the SDBS

Spectral data are of many types and some types of them has already been built up to data bases; the author, et al., decided to prepare a new type of data base never seen before and having the following two features:

(1) Full-Spectrum Data Base. A spectrum data must essentially be a pattern data as shown below in an example. Many of the data bases so far available, nevertheless, represent the file of a single feature of the data involved such as the peak energy value or the relative intensity. The SDBS, on the other hand, is a data base in which the entire spectrum measured is filed and which, hence, contains all relevant information. At the output of a computer, therefore, the spectrum is represented as if recorded on the paper in actual measurement. The data base also involves relevant numerical values, and this makes it possible to work out computer software with ease when new methods of application are projected.

(2) Composite Data Base Involving Several Types of Spectra. In the identification of organic compounds, infrared-, NMR-, and mass-spectra are of particular importance and work as the trio of supreme value. These three types of spectra--four types if C-NMR and 'H-NMR are classified separately--together with ESR and Raman spectra, totaling five types, account for the SDBS. By making access to the SDBS, any spectra is accessible; more than one spectra are available simultaneously in order to identify an unknown sample.

3. System Structure

In Figure 1 is shown the structure of the system SDBS. The host computer is FACOM M380 of the research information processing system (RIPS) of the Industrial Science and Technology Agency and is operating under the OSIV/F4. The data are obtained by means of actual measurement with a spectrometer and, after having been stored in the minicomputer connected with the spectrometer, is transmitted to the host computer either by means of a magnetic tape as the medium or by a file in case the minicomputer is connected with the host computer by the remote batch.

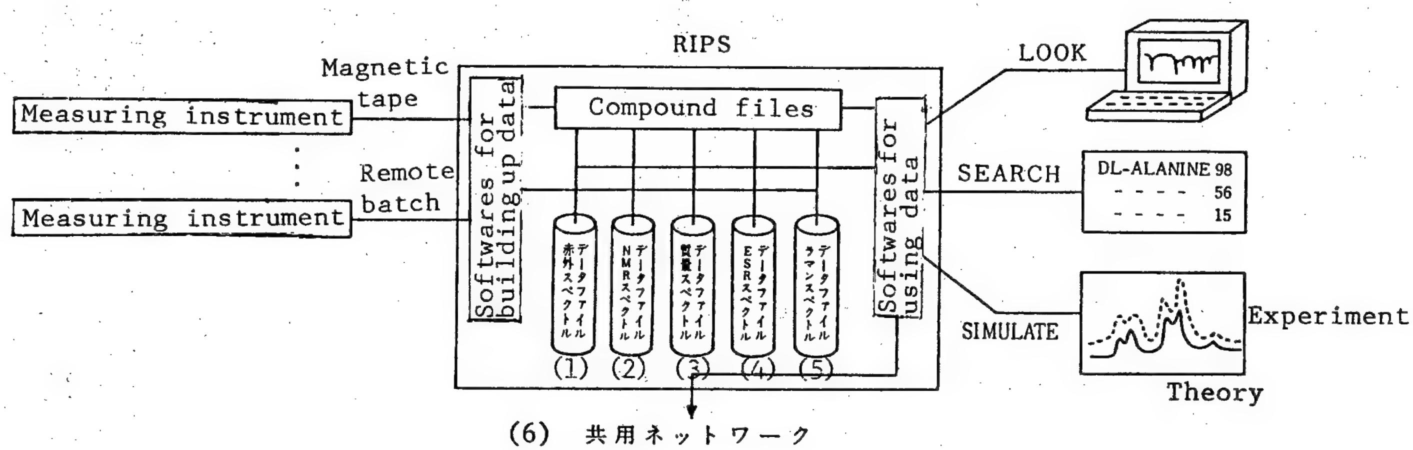


Figure 1. Outline of the SDBS System

Key:

1. Data file for infrared spectra
2. Data file for NMR spectra
3. Data file for mass spectra
4. Data file for ESR spectra
5. Data file for Raman spectra
6. Common use network

Each of the spectral-data files is connected with the compound file. The compound file, in turn, has the names of compounds, their structural formula, and their structural factors recorded in it. As can be seen by actually practicing the data base build-up, it is possible to make measurement for data and to deposit them into a file in a mechanical fashion once the hard- and softwares involved have been completed, whereas it requires many hands to learn every spectral data filed and to manage them properly since the task involved resists systematization. The difficulty involved is partly due to the fact that more than one name is assigned to one compound and, hence, one needs a high level of expert knowledge and endurance if he is to learn whether two substances are identical or not on the basis of names alone. Many of the pharmaceutical and chemical corporations have concerned themselves with this matter, which has led to the currently dominant idea of building up a data base for molecular structures by means of computer graphics and combining the data base with that of the spectra. The relevant softwares have been put on the market. This method is not a remedy; however, in view of the necessity of building up a data base for molecular structures along with names, this method of combination must be the best tentative one.

The compound file uses FAIRS, which is a data base management system, DBMS, for reference to literature, of FACOM. The FAIRS, nevertheless, cannot deal with the spectral data developed by the author, et al., and, hence, a software has been developed which is capable of using FAIRS together with a spectral data file prepared outside of the FAIRS.

4. Software Available

The SDBS offers three services to the user as shown in the right part of Figure 1. The first service is to look up data required on the basis of the name of a compound, etc., and referred to as LOOK. A flow-chart of the LOOK is shown in Figure 2. By selecting the key to the LOOK command, the user gets access to the compound file, namely, he can look up a compound on the basis of either the name or the molecular formula or structural factors. The spectral data the user is looking up are given in pattern at the graphic terminal or the laser printer or the XY plotter, among others. Those who have not these terminals available, may depend for data on the character display and line printer to some limited extent. In Figures 3 and 4 are given an infrared and a C-NMR spectrum, respectively, put out at the laser printer. Though the authors do not go into details here, the relevant software involves various ingenious devices made by the author, et al., for the user's convenience. Though the software may have some shade of amateurishness so far as it has not been worked out by an expert, it, nevertheless, displays various fine devices for an amateur and, besides, can have some shade characteristic of spectral experts.

The second service, SEARCH, involves identification of an unknown sample by feeding, at a terminal, spectral data obtained by the user for the sample. This service has represented the main objective of the data base build-up to date. The SDBS is capable of the above identification using either infrared or mass or C-NMR spectra. The feature of this system is that it can identify substances by the use of peak-intensity information with a higher accuracy and

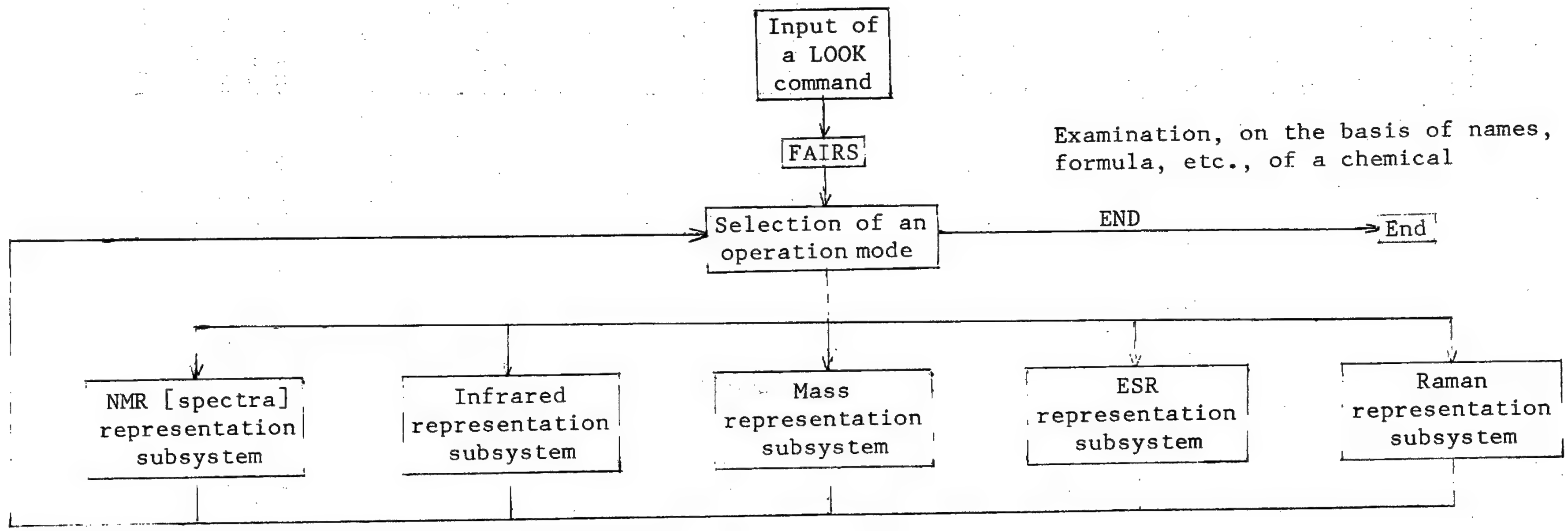
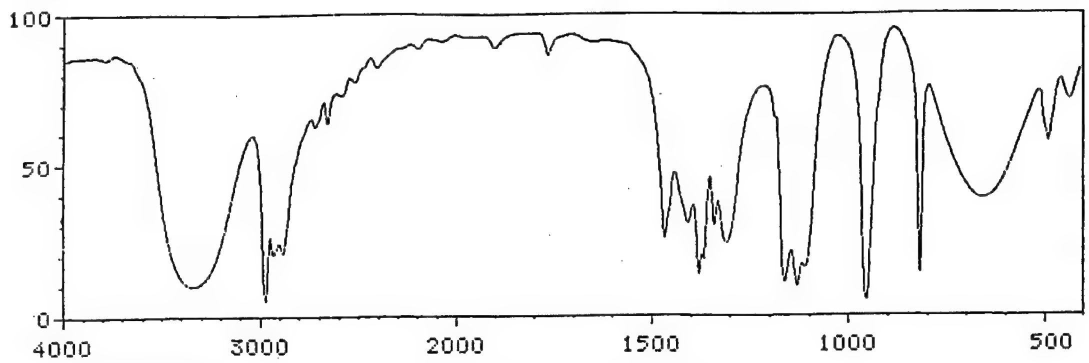


Figure 2. Flowchart of LOOK

LOOKIR>



2-PROPANOL
SDBS NO = 2149 IR-NIDA-03326 : LIQUID FILM

***** PEAK INFORMATION *****

3344.5- 9.7	2387.0-83.9	1161.7-10.9
3333.5- 9.8	2197.5-88.4	1130.0- 9.6
2972.0- 5.3	1902.5-88.8	1109.5-15.5
2933.0-20.1	1766.0-86.3	953.5- 4.9
2906.5-23.9	1467.0-25.2	817.5-13.6
2883.5-20.8	1408.5-30.3	659.5-38.2
2721.5-62.5	1379.2-13.5	654.0-38.3
2658.5-63.4	1367.5-18.4	489.7-56.8
2520.5-77.2	1340.5-29.5	434.7-71.0
2408.0-82.0	1309.0-23.8	

Figure 3. Example of an Output, at a Graphic Terminal, of an Infrared Spectrum

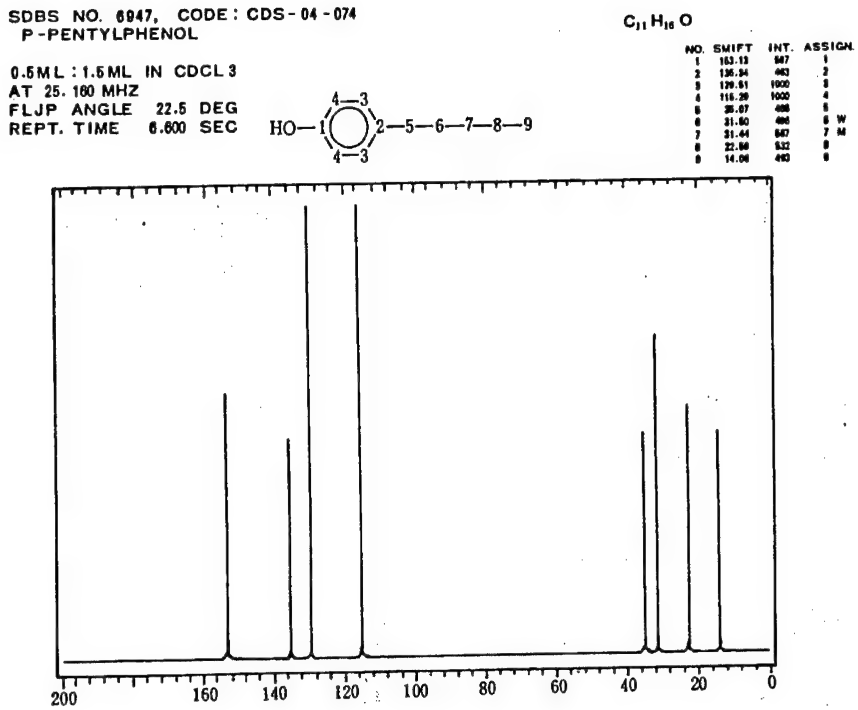


Figure 4. Example of an Output, at a Laser Printer, of a ^{13}C-NMR Spectrum

that it can make identification on the basis of the above three types of spectra combined.

In the third service of this system, spectra are computed on the theoretical basis in order to compare with the corresponding experimental data or to analyse the data. The service, referred to as SIMULATE, is available for 1H-NMR and ESR spectra.

5. Use of the Data Base by General Customers

A data base such as the SDBS produced would serve no purpose if it were not for people who want to use it. It will serve no purpose again even if there is one who likes to utilize it, if he has not an access to the relevant host computer. As far as the present system is concerned, every member of the Industrial Science and Technology Agency can have access to the system since the system has been set up in the Research Information Processing Center, RIPS, of the Agency. It is further desired, however, that such a data base be rendered available to people in general; and it is hoped, at this juncture, that a Basic Technology Research Enhancement Center, tentatively named, which is to start this October and to provide information on research to people in general as part of its assigned work, will fulfill the role of rendering the data base of the RIPS available to people in general to the full extent.

The RIPS currently has not the function of scientific and technological computation separated from that of information processing, which is not necessarily an ideal condition. It seems necessary in future that the large-size computer divide into two types--one primarily for scientific and technological computation and for gigantic schemes, involving the function of the supercomputer, and one largely for information exchanges based on data bases, with appropriate hard- and softwares for both. Ordinary computation and small data bases, in turn, are to be dealt with by the use of personal computers, etc.

It is a matter of course that a computer network must be worked out for information exchange; it is hoped that the Basic Technology Research Enhancement Center grow and, jointly with JICST, form the center of information exchange.

The SDBS is expected to be made available by the center. At the outset, the data is offered only by magnetic tapes as the medium, but it is hoped that they be offered by means of an on-line real-time system in future and that then the data base be further expanded. It is intended, they say, that, besides the SDBS, research projects and annual bulletins of the research and experiment institutes of the Industrial Science and Technology Agency are offered by the above new center as are also picture informations on research of the RIPS. It is hoped that the center will grow in future and data bases of high necessity be orderly will be stored there, so that the industrial basis of the nation will be expanded and that, at the same time, the international position of the nation with respect to research information will be consolidated.

Tax System for Research

Tokyo KOGYO GIJUTSU in Japanese Jun 85 pp 36-39

[Article by Kazuo Kashio, former member of the Technology Promotion Division of the General Coordination Department, Agency of Industrial Science and Technology : "Institution of a Tax System for the Enhancement of Research and Development of Basic Technology"]

[Text] 1. Objective of the Tax System

The basic technology sector such as new materials, biotechnology, and electronics is expected to play the role of traction-force for the economic development of the coming years by developing new industrial fields and by comprehensively renovating existing industries. Therefore, enhancement of technology development in this sector is of utmost importance for the upgrading of the industrial structure of the nation and the creation and maintenance of employment opportunities among other things, in future. Allowing for the importance of the development of these basic technologies, Western industrially advanced nations, both the government and private organizations in concert, have long been striving actively for the development of the relevant technologies.

The nation, at this juncture, has decided to enhance the research and development of the basic technologies by means of a tax system, that is, by instituting a tax abatement system, from the year 1985 on, for the depreciable asset required in carrying out research and development in the field of basic technologies--or assets for use in the developmental research of the basic technologies--and by designating the relevant assets.

This tax abatement system is aimed at facilitation of acquisition of the experimental facilities that are used frequently in the research and development of the basic technologies and which is often highly sophisticated and expensive, by reducing the economic burden for the acquisition, on the grounds that these facilities act as a dominant factor in promoting relevant research and development.

This tax system, meanwhile, is put into effect in an expanded form of the current tax reduction system for increased research and experiment costs--Article 10, and Clause 4 Article 42--of the Tax Abatement Law.

2. Outline of the System

(1) Subjects qualified are natural and legal persons making blue paper report.

(2) System. The following quantities are reduced from corporate or income taxes: (a) For the expenditure in research and experiment of a current business year that exceeds in quantity the highest of the previous business

years, 20 percent of the quantity that exceeds is amenable to the relevant reduction; this is the current Tax Reduction System for Increased Research and Experiment Cost. (b) Seven percent of the purchased value of the assets obtained for the developmental research of the basic technologies is amenable to reduction from the relevant tax; this is a new institution, the Tax System for the Enhancement of Research and Development of the Basic Technologies, which adds to the above tax reduction article. (c) Six percent of the research and experiment cost of a current business year for the small- and intermediate-size corporations is also amenable to the relevant reduction; this is again a new institution, the Tax System for the Consolidation of the technology base of the small- and intermediate-size corporations; this system is instituted simultaneously with the preceeding system (b) and one has to choose either of the two tax reduction systems if both apply.

(3) Maximal Amounts Reducible. The maximal reducible amount of taxes is limited to 15 percent of the corporate or income tax of the business year. It is limited to 10 percent as in the previous years, however, in case the tax reduction system (a) along applies. This implies that the 15 percent limit applies to any tax reduction case where either the tax reduction system (b) or (c) is included, that is, to the cases to which either the system (b) or (c) is singly amenable, to which both of the systems (a) and (b) are amenable as the sum, and to which both of the systems (a) and (c) are amenable as the sum. For example, when the amount amenable to the system (a) is 14 percent of the total tax and the one to the system (b) is 3 percent, the maximal reducible limit is 15 percent and not 10 percent + 3 percent = 13 percent. Likewise, when the amount amenable to (a) is 9 percent and the one to (b) is 12 percent, the limit is 15 percent and not 9 percent + 12 percent = 21 percent.

(4) Items Included in the List of the Designated Assets for the Developmental Research of the Basic Technology

The assets for the developmental research of the basic technology amenable to the tax reduction system (b) of (2) is defined as the ones amenable to depreciation that are used in the research and experiment carried out, specifically, either on technologies which are based on new principles such as the technology for enhancing functions of a material by making the best of some of its characteristics which have not yet been put to use, and technologies for enhancing rapidly the function of processing, accumulating, and transmitting information by making the utmost of the characteristics of electronic movement, or on the technology which can rapidly enhance existing technologies. The said assets are designated by the finance minister as greatly contributing to the research and development involved. The relevant depreciation amenable assets designated by the finance minister are given in a table attached to this article. [Table 3]

The classification of technological sectors used in Table 2 represents the sectors in which the above assets for the developmental research of the basic technology are predominantly used (the assets were selected on the basis of their definition described above) and technological elements for each of the sectors may be subdivided as follows: (a) new material technology that involves technologies for designing, manufacturing, analysing and evaluating materials of metals, organic and inorganic substances, and composite

Table 1. Tax Systems etc. for the Enhancement of Research and Development in Major Nations

U.S.A.	- Tax reduction system for an increased experimental research cost, instituted in 1981 : tax reduction by 25 percent of an increased research cost - Accelerated capital recovery system (ACRS) : 3 years for experimental research equipments
West Germany	- Special depreciation by 40 percent of an experimental research asset in the first year, instituted in 1984 - Subsidy system for investment : subsidies amounting to 7.5 to 20.0 percent of the amount invested
Britain	- System for the early recovery of invested capitals : 100 percent of an experimental research asset in the first year [for special depreciation] - Subsidy system for research and development : 25 to 50 percent of a research and development cost
Japan	- Tax reduction system for an increased research and experiment cost, instituted in 1983 : 25 percent of the relevant increase over a year ago - Subsidy system for research and development : Fr25.000 per person newly employed in connection with an investment on research facilities

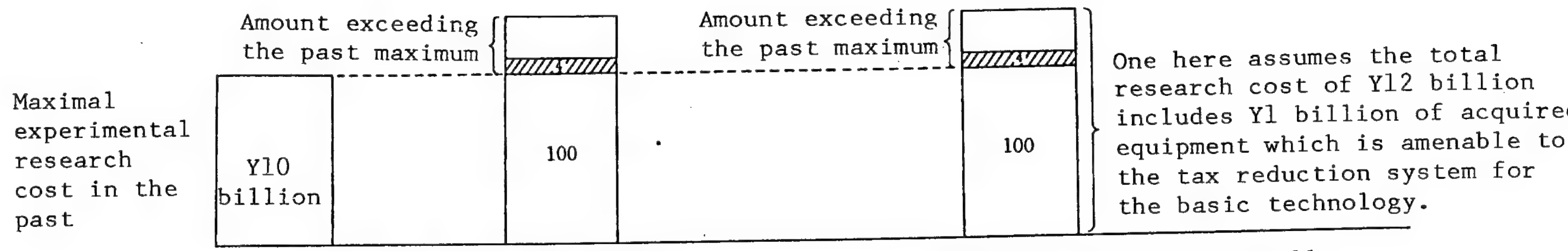
Table 2. Equipment Amenable to the Tax System for the Enhancement of Research and Development of the Basic Technology

Technical field	New material technologies	Biotechnologies	Advanced electronic technologies	Robots of high performance and advanced technology for manufacturing and processing	Extreme environmental technology	Innovative process technology	Total
Number of items	61	26	31	22	25	6	126
Number of equipments	114	27	36	23	30	9	207

Note: Equipment alone is designated in the relevant notification and the above technical fields are classified for convenience.

Case 1
No equipment is amenable to the tax reduction system related to the basic technology

Case 2
Some equipment is amenable to the tax reduction system of the basic technology



Case 1

Amount reducible generally

Amount exceeding the past maximum of Y2 billion multiplied by 0.2 equals Y400 million.

Limit to the relevant tax reduction : 10 percent of the corporate tax

- Assuming the corporate tax for the current business year at Y3 billion

$30\times0.1 = \boxed{3} < 4$

- Assuming the corporate tax for the year at Y5 billion

$50\times0.1 = 5 > \boxed{4}$

Tax reduction limit

Case 2

Amount reducible generally

Amount exceeding the past maximum of Y2 billion multiplied by 0.2
Y1 billion multiplied by 0.7 equals Y470 million

Limit to the relevant tax reduction : 15 percent of the corporate tax

- Assuming the corporate tax for the current business year at Y3 billion

$30\times0.15 = \boxed{4.5} < 4.7$

- Assuming the corporate tax for the year at Y5 billion

$50\times0.15 = 7.5 > \boxed{4.7}$

Tax reduction limit

[Figure] Examples of Computation for the Tax Reduction

Table 3. Notification No. 47 of the Finance Ministry dated March 30, 1985, designated the assets for the developmental research of the basic technology amenable to tax reduction based on the Tax System for the Enhancement of Research and Development of the Basic Technology as follows.

The relevant equipment is each subjected to limitations, in their specifications for structure, performance, etc.; refer to the above notification for the details.

Number	Name of equipment, etc.
1	Clean room for research purpose
2	Room for the experiment of gene recombination
3	Spectrographic analyser
4	X-ray analyser
5	Mass spectrometer
6	Optical dispersion detector
7	Ion-chromatography equipment
8	Equipment for NMR absorption
9	Equipment for electro-paramagnetic resonance absorption
10	Photo-electron spectroscopy equipment
11	Equipment for the measurement of surface conditions
12	Equipment for X-ray tomography
13	Automated apparatus for the cleaving of nucleic acids
14	Automated apparatus for the cleaving of peptids
15	Apparatus for the manipulation of cells with microscope
16	Amino acids analyser
17	Apparatus for counting the number of microbes and cells
18	Apparatus for measuring immunity
19	Apparatus for measuring very fine particles
20	Electrostatic classifier of the size of fine particles
21	Apparatus for the measurement of particle size distribution
22	Machine strength tester
23	High temperature heat shock tester
24	Impact tester
25	Friction and abrasion tester
26	Apparatus for measurement of thermal constant
27	Precision apparatus for testing magnetization characteristics
28	Thermal analyser
29	Equipment for experimenting corrosion at high temperature
30	Equipment for visco-elasticity tests
31	Equipment for testing high speed rotation
32	Equipment for testing and assessing electromagnetic and optical properties for research purpose
33	Equipment for testing and assessing IC's with high precision and at high speeds for research purpose

[Table continued on following page]

[Table 3 continued]

Number	Name of equipment, etc.
34	Equipment for testing and assessing planar indicators of elementary devices for research purpose
35	Equipment for testing and assessing cathod display discharge tube for research purpose
36	Equipment for testing and assessing connectors of high performance for research purpose
37	Infrared surface thermometer
38	Apparatus for testing and assessing semiconductor chips for research purpose
39	Manual probe for research purpose
40	Instruments for measuring the roughness of surfaces by means of needle contact
41	Ellipsometer for research purpose
42	Equipment for measuring laser for research purpose
43	Equipment for three dimensional measurement for research purpose
44	Equipment for measuring robotic activity for research purpose
45	Measuring instruments of the light-wave type for research purpose
46	Non-contacting optical type of instruments for measuring the change of positions for research purpose
47	Instruments for measuring liquid pressures
48	Analyser of toothed wheels of high performance
49	Equipment for testing and analysing vibration and structure
50	Detector of helium leakage for research purpose
51	Standard (meter) of super-high vacuum
52	Equipment for calibration of extremely low temperatures
53	Equipment for calibration of extremely high vacuum conditions
54	Image processor for designing molecular structure
55	Super-high speed computer for use in scientific and technological computation
56	Electron microscope
57	Supersonic wave microscope
58	Equipment for experimenting plasma-dissolution
59	Equipment for experimenting electron beam dissolution
60	Equipment for experimenting dissolution under controlled atmospheric conditions
61	Equipment for experimenting reactions under highly controlled atmospheric conditions
62	Equipment for experimenting synthetic reactions under super-high pressure
63	Equipment for experimenting polymerization of high viscosity polymers
64	Equipment for experimenting differential selection of cells
65	Equipment for experimenting purification of nucleic acids

[Table continued on following page]

[Table 3 continued]

Number	Name of equipment, etc.
66	Equipment for experimenting purification of peptids
67	Equipment for classifying gas streams by means of centrifugation
68	Equipment for experimenting firing and sintering under highly controlled conditions
69	Equipment for experimenting sintering under compression
70	Annealing apparatus of high performance for research purpose
71	Equipment for experimenting molding by injection and extruding
72	Equipment for experimenting molding by fusion
73	Cold isostatic pressing apparatus for research purpose
74	Equipment for spinning of high performance for research purpose
75	Equipment for the growth of whiskers for research purpose
76	Equipment for producing super-thin films for research purpose
77	Equipment for producing film
78	Equipment for cutting very small patterns for research purpose
79	Apparatus for welding and adhesion for research purpose
80	Cutting machine by means of laser beam for research purpose
81	Superplastic hammering press for research purpose
82	Equipment for processing mirror surface for research purpose
83	Machine tools of high precision for research purpose
84	Grinding machines of the cleave-feed type of high rigidity for research purposes
85	Equipment for electric casting of high performance for research purpose
86	Equipment for super plastic powder molding for research purpose
87	Ovens for soldering in vacuum for research purpose
88	Equipment for casting of high performance for research purpose
89	Equipment for molecular line expitaxial growth for research purpose
90	Equipment for chemical vapor-phase reaction for research purpose
91	Equipment for physical vapor-phase vacuum deposition for research purpose
92	Equipment for trial manufacture of single crystals
93	Equipment for experimenting solidification by quenching
94	Equipment for the trial manufacture of fine particles
95	Equipment for molding by unidirectional solidification
96	Equipment for experimenting coating
97	Equipment for experimenting flam spay
98	Equipment of vapor-phase etching for pattern formation in semiconductors for research purpose
99	Equipment for ion implantation for research purpose
100	Equipment for super-high voltage processing for research purpose
101	Equipment for the formation of metal films by means of excimer laser for research purpose

[Table continued on following page]

[Table 3 continued]

Number	Name of equipment, etc.
102	Equipment for laser trimming for research purpose
103	Equipment for experimenting the exposure system [or exposure to beams of wafers]
104	Equipment of experiments for strengthening fibers and producing composite fibers
105	Equipment for experimenting high-degree impregnation
106	Equipment for automated manufacture of culture media for research purpose
107	High-pressure sterilizing apparatus for research purpose
108	Apparatus for automated implantation of [microbial] colonies for research purpose
109	Equipment for experimenting culture of cells and tissues
110	Equipment for experimenting the synthesis of nucleic acids
111	Equipment for experimenting the synthesis of peptids
112	Equipment for experimenting the cell fusion
113	Equipment for experimenting bioreactors
114	Clean bench for studying dust-collection efficiency
115	Safety cabinets for research purpose
116	Equipment for producing standardized particles
117	Equipment for refining hydrogen to high purity for research purpose
118	Equipment for refining nitrogen to high purity for research purpose
119	Equipment for refining oxygen to high purity for research purpose
120	Equipment for liquifying helium for research purpose
121	Facilities for experimenting recovery of scarce metals
122	Equipment for the experiment of smelting by means of prereduction and fusion or molton reduction
123	Equipment for experimenting continuous steel manufacture of the composite, multifarious-function type
124	Equipment for experimenting in-phase continuous casting and rolling
125	Facilities for experimenting manufacture of basic chemicals of the carbon mono-oxide series
126	Equipment for experimenting supercritical separation

substances; (b) biotechnology that is made up of technologies of gene-recombination, cell fusion, bioreactors and massive cell culture, which are made the utmost of for useful commodities; (c) advanced electronic technologies which are made up of optoelectronics, advanced communication technologies related to the comprehensive communication network, advanced information processing technology such as non-Von Neumann type processing and large capacity memories, and other technologies associated with enhanced functioning of electronic devices and circuit component; (d) robots of enhanced function, and advanced technologies for manufacture and processing, which comprise intelligent robots, hazardous environment robots, etc., for the former and FMS and other technologies of production and processing for products of high quality and high precision for the latter; (e) technologies for creating and maintaining an environmental condition which is far different from that of the ordinary and which, in this tax abatement system, is made up of super vacuum, extreme low temperature, and super cleaness; (f) technologies for bringing about a comprehensive innovation of production and processing by shortening existing production processes or by introducing a continuous or new process, among others, and hence enhanced functioning of products and improved productivity.

(5) Period of Application

From 1 April 1985, through 31 March 1988, with the institution of the relevant tax reduction system, the application period of the current Tax Reduction System for Increased Experimental and Research Cost which, otherwise, would expire at the end of fiscal 1985, is extended by 2 years up to the end of March 1988.

(b) Application of Other Tax Reduction Systems Excluded

The depreciation amenable assets to which the Tax System for the Enhancement of Research and Development of the Basic Technology is applicable are not amenable to other tax reduction laws such as the following: special depreciation laws other than the above, the extra depreciation law, the tax reduction systems of the Tax System for the Enhancement of Investment for Enhanced Efficiency of Energy Utilization, etc., the Tax System for the Enhancement of Investment for the Development of New Technologies of Small and Intermediate Enterprises, and others.

(7) Application of Local Taxes Involved

Of the corporate resident taxes, made up of prefectural and municipal taxes, those parts of which the amount is proportional to that of the government corporate tax is calculated on the basis of the government corporate tax which is obtained by the tax reduction relevant to the Tax System for the Enhancement of Research and Development of the Basic Technologies and the one for the Consolidation of Technological Basis of the Small- and Medium-Sized Enterprises.

The above method of calculation for the corporate resident tax does not apply to the tax reduction based on the current Tax Reduction System. Corporate resident tax is calculated on the basis of the government corporate tax before relevant tax reduction is made, as it has been in previous years.

(8) Amounts of Total Annual Tax Reductions Involved: Year 1, Y13 billion; the following years: Y16 billion.

Research Management Strategy

Tokyo KOGYO GIJUTSU in Japanese Jun 85 pp 39-42

[Article by Kiyoshi Inoue, president and executive of the Inoue Japan Research Institute, Ltd.: "Strategy of Research Management for Corporations of the Research and Development Type in the Nation"]

[Text] 1. Introduction

Corporations of the research and development type are presently in the spotlight as the activating agent to revitalize the stagnated economy of industrially advanced nations, referred to as the disease of civilization.

Therefore, it must be very useful for the activity of corporations of the coming years, as a reference, and for learning the characteristics of the economy of the present and the future, if the features of the group of corporations of the research and development type are explored and the question of how these corporations can revitalize the present stagnated economy is considered, and if suggestions are made on the strategy of research management for this type of corporations. In the following, hence, are presented the author's suggestions for the relevant issue.

(1) Definition of the Research and Development Type of Corporations

Research and development corporations, also known as high technology corporations, are represented by a group of corporations of the semiconductor industry located in an area centered at Palo Alto in California, United States, which has become well-known as the Silicon Valley. This type of corporation, though variously defined, is generally characterized by: (a) small-sized corporations independent of the control of the large-sized corporations; (b) corporations set up in recent years and having comparatively short history; (c) corporations with high expenditures in research and development which account for 5 percent or more of the total sales; (d) corporations which are competitive on the market not in quantity but in quality, and ones with greater effects of technology buildup; corporations involving advanced technologies such as basic technologies, software technologies, extreme [environment] technologies, and new material technologies.

The research and development type of corporation, in addition, has the management of corporations carried out in an aggressive manner, essentially in contrast to other types of corporations that are defensive in management.

The most important of the items listed above for the characteristics of the research and development type of corporations is the fourth, involving free competition in quality. The reason is that the competition in quality, as opposed to that in quantity, can lead to the creation of new information. This new information alone allows real economic activity for corporations, which, in turn, permits the competition in quality again.

Of importance here is the question of what kinds of information are being dealt with by a corporation in its economic activity. The greater the build-up effect of a type of information, the better, and the type of information with the largest build-up effect is based on research. This does not imply, however, that any research will do; it is of utmost importance to select a subject of research in which the unknown portion involved is likely to be resolved on its own in a limited period of time.

(2) Disease of Civilization

The economy of the industrially advanced nations rapidly became stagnated after the first oil shock; Britain was the first victim of the recession followed by France, Italy, and finally by the United States. Even West Germany which was an "honor student" in the postwar economy now sees its economy affected by the same phenomena. This phenomena of economic inactivity is called the disease of civilization.

In terms of economy, these phenomena represent a condition in which the trend of inflation has shifted to that of deflation rapidly. This implies that the process of an economic change can be brought about by a technology innovation, that is, a technological innovation makes the core of the industry, leading to the formation of a new paradigm . The disease of civilization emerges because of this requirement for a change of the technology paradigm.

Technology grows in the economic society, but begins to lose its value with time; it, therefore, has to maintain its value only by innovation. The value of a technology, nevertheless, has its effects on the community: a technology satisfies a demand of a community, the community becomes a satisfied state with respect to the demand and at this juncture the value of the technology becomes lost to the relevant community, though the community with the relevant demand satisfied has become different from ones with the demand not yet satisfied.

(3) Research and Development

Research is primarily made up of academic research involving basic or pure research and scientific research involving application research, and aims largely at discovery and invention. This type of research is comparatively basic and belongs rather to the domain of science which is separated from, and has no direct connection with, economy. Developmental research, on the other hand, is more close to economy and involves largely technology development of a stage that is likely to bring about a technology innovation. If research and development is to exist as an industry, it must be connected to economic activity via further research in production and experiment.

Research and development is dependent upon the science of scholars and scientists and also upon technological experts and skilled workers that utilize the science, and hence cannot work if either of these is unavailable. Only from this viewpoint one can expect to achieve a technological innovation and to render the relevant work profitable.

The scholar and the scientist require primarily the will and the knowledge that drives them to the exploration of a subject, which, together with a passionate art and a creative mind that push the exploration, lead to the attainment of a new theory of acquision of a new patent right of substantial practical usefulness. In response to such an achievement, a group of technologists make computations and designing steadfast, carry out trial manufacture and relevant assessment, and exert marketing efforts including maintenance, control, and software development, of the relevant products, thereby triggering an economic development. The outcome is the development of a technology innovation in the economy which can change the paradigm.

(4) Strategy for Research Management

The research and development type of corporation must, in principle, have a research and development division, as discussed above; that is, it must have a division for scientific research and for developmental research wherein research is carried out in technology for "real" enterprises.

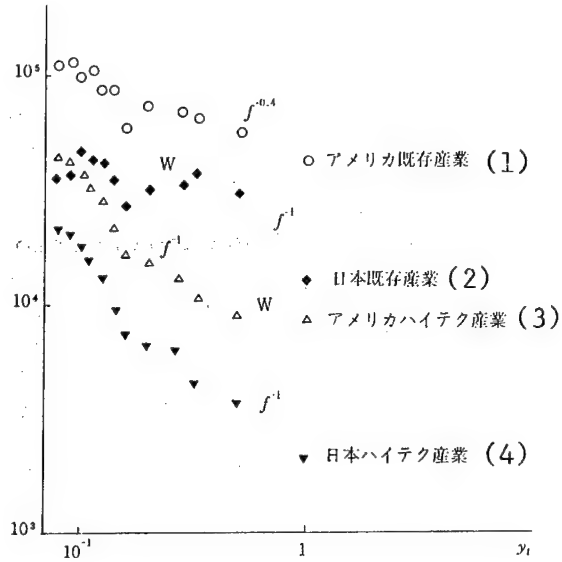
Meanwhile, one often mistakes mere testing and fabrication of a prototype for real research. This is a grave error that may lead to an irreparable failure of a corporation, since criterion for the judgment of results as well as objectives involved are quite different.

Corporations which use existing technologies in combination and which thus earn high profits are sometimes called the research and development type or high-tech. This is another mistaken definition. They are outside of the category of the research and development and are referred to as "false" enterprises as against the "real" above.

The research and development type of corporations further requires having something to do with such technologies as generally called software technologies, advanced super technologies (extreme [environment] technologies) or new materials (including organic life) and, at this juncture, the kind of science involved is the key factor. It must, above all, have the prospect of high profitability.

The process of a technological development corresponds to the process of inflation which is brought about by virtue of a creative technology. The process leads to the creation of demands in the community for the relevant products. When the community requires increasing demands for it, the development of the technology ceases, making a matured technology. The relationship between a community and a technology is a repetition of this cycle.

The cycles of deflation and inflation are also repeated in one corporation: in deflation, research is made for creation and technologies developed. The resulting products are supplied to the community bringing about a technological innovation. In this process, inflation replaces deflation with rapid improvement in corporate performance. In such repetitions and fluctuations resides the key to the expansion of a corporation, which has to adapt to such conditions, while engaging in research and development.



Key:

1. Existing industries of the United States
2. Existing industries of Japan
3. High technology industries of the United States
4. High technology industries of Japan

It is possible to evaluate unreliable economic conditions regardless of the time on the basis of the width of play in these fluctuating changes. The slope of the spectrum [or curve] is inversely proportional to the frequency [of the cycle] in the plot of time versus the amount of investment according to the data of the Survey Division of Japan Development Bank.

(5) Age of Information

The competition in quantity led to quantity production and quantity consumption. The industrial society has matured and turned into the information society wherein there emerges a tendency for the economy, politics, and technology, which, in the past, grew independently of each other, to approach and partly contact each other, beginning interpenetration. Since those parts interpenetrated yield new information, each of the above three sectors are affected by the others and, hence, concepts which prevailed in the world of quantitative competition have become no longer tenable. An extremely powerful measure in such an information society is the act of research and development as an incentive to the creation of new information. The competition in quality leads to the creation of new information.

Corporations in future are characterized either by market specialization or by technology specialization. Both types, nevertheless, are required to yield new information by succeeding in effective research.

Conclusion

The strategy for the management of research undertaken by a corporation of the research and development type is, first of all, to make a discovery or invention in a field of science that is intimately connected with economy and thus to have a technology of its own. After having the relevant technology subjected to various improvements, a subject of developmental research which affords high profitability with least effort is picked up and constant creative efforts are made, while a certain cycle of growth followed by a period of stabilization and then by a decay, which is invariably the fate of the products, is allowed for.

Assessment of Fine Ceramics

Tokyo KOGYO GIJUTSU in Japanese Jun 85 pp 42-45

[Article by Ceramics Office of the Consumer Goods Industry Bureau, MITI: Development of New Materials and Relevant Testing and Assessment--for Fine Ceramics"]

[Text] The new materials have been in the limelight as one field of the advanced technologies on which the economic development of the nation in future is based, with the size of the market for the new materials and relevant existing materials combined having been estimated at Y10.2 trillion for the year 2000 according to the Industrial Structure Research Association. The new materials in this article mean materials with high values added, in

which high functions and special structures are materialized by means of correcting shortcomings of existing materials and by eliciting superior properties from them, and presently comprises four types--polymers of enhanced function, fine ceramics, new metal materials, and composite materials--these are materials for which research and development is underway and which have the prospect of enormous development in future.

These new materials, nevertheless, are apparantly still in initial stages of development and technologically immature in many aspects. They involve many problems to be solved if they are to develop in future. This is due to the fact that the development of new materials, and particularly those for structural materials, absolutely requires building up knowledge of the relevant basic research to be carried out over long years, and building up reliable data, not just an improvement on existing technologies.

This article deals with testing and assessment which is indispensable in securing reliable data, with fine ceramics being used as the example.

1. Necessity for Assessment Test on Fine Ceramics

Fine ceramics have excellent heat-resistant and antiabrasive properties and hence have a high prospect as materials of high strength at high temperature particularly, for example, for automobile engine components, gas turbine components, and jet engine components, and also as anticorrosive, antiabrasive and other types of structural materials.

They, nevertheless, find only very limited practical applications for the present owing to its fragility which, one may say, is its essential nature. Even for automobile engine components which are now in the limelight, for example, the material is used only partly in auxiliary combustion chamber of the diesel engine and in the heater plug and rocker arms as chips. If the material is to become credible as a structural material, the problem of improving mechanical strength including elimination of fragility have to be solved as the most important. This involves elimination of defects, which cause fracture, by means of rendering the material more pure and with finer particles and by means of improvement in molding and sintering technologies. It also involves, among others, improvement of sintering agents used and increase of strength by converting the material to a composite one such that the quality of the material itself is improved.

Improvement of the mechanical strength of a fine ceramic, however, is not sufficient condition for the application of the material in structural materials. It is also important to limit the ranges of variation in qualities of the material and to learn accurate data for various physical properties of the material. A ceramic material is usable as a structural material if accurate data are available on, for instance, how much force is necessary at a particular temperature to destroy the material or how long the material has to be used to destroy it. The range of application of the material can be expanded even if there is some variation in the properties of products if those that do not meet the required criteria can be elminated during testing.

To be brief, if a fine ceramic material is to be widely available as a

structural material, as existing metals are, it needs to be subjected to testings and assessments such that it is put on the market with relevant data which are credible and, in particular, comparable to those of other materials and by which, thus, appropriate designing is permitted.

2. Standardization of Testings and Assessments

The standardization of the criteria for assessment, or the methods of testings and assessments, of the material is indispensable for obtaining these important data. Some of the relevant methods, nevertheless, have yet to be set up, nor are most of them on a unified basis. The corporations and the research organizations involved, therefore, have been each carrying out experiments of testings and assessments using equipment and methods of their own. Hence, data for physical properties obtained are often not comparable with each other. The users of fine ceramic materials, in consequence, are unable to compare the physical properties of various relevant materials with each other with accuracy on the basis of pieces of information afforded by each of the makers, and frequently have to carry out experiments of reassessment on their own. Relevant makers, in turn, are having difficulty in comparing materials of their own with those developed by others. Hence, in setting up their research targets there is the possibility of causing trouble between a maker and a user in connection with a fine-ceramic material consigned.

It is, therefore, urgently required to push the standardization of the method of testings and assessments of fine ceramic materials in parallel with development of the materials. Nevertheless, the bending test at ordinary temperatures, at present, is the only method of testings and assessments included in the JIS for fine ceramics, with a draft for the modulus of elasticity tests at ordinary temperature only having been worked out for inclusion to the same list. Standardized methods of testing, therefore, should be set up at the earliest possible time. The Science and Technology Agency, meanwhile, has had a survey and research on the standardization of methods of testing and assessment for fine ceramic materials carried out by the Fine Ceramics Association since fiscal 1983, and presently considers standardization of the following 11 items necessary in addition to the above two methods in connection with the physical properties of fine ceramic materials as structural materials: The tests related to basic physical properties are those for bending strength at high temperature, thermal expansion coefficient, thermal conductance, hardness, and fracture toughness. The tests related to strength against immediate destruction are those for tensile strength, strength against heat shock, strength against mechanical shock, and antiabrasive property. The test related to delayed destructive effects is one for creep; the test related to environmental effects is one for the resistance to oxidation.

In Figure 1, meanwhile, are shown methods of test and assessment for fine ceramic materials as classified by sequences of the manufacturing process.

As for the particle size of a ceramic powder for instance, corporations involved are carrying out tests each on their own and no methods of testing on which the maker and the user can agree have yet been set up, thus preventing

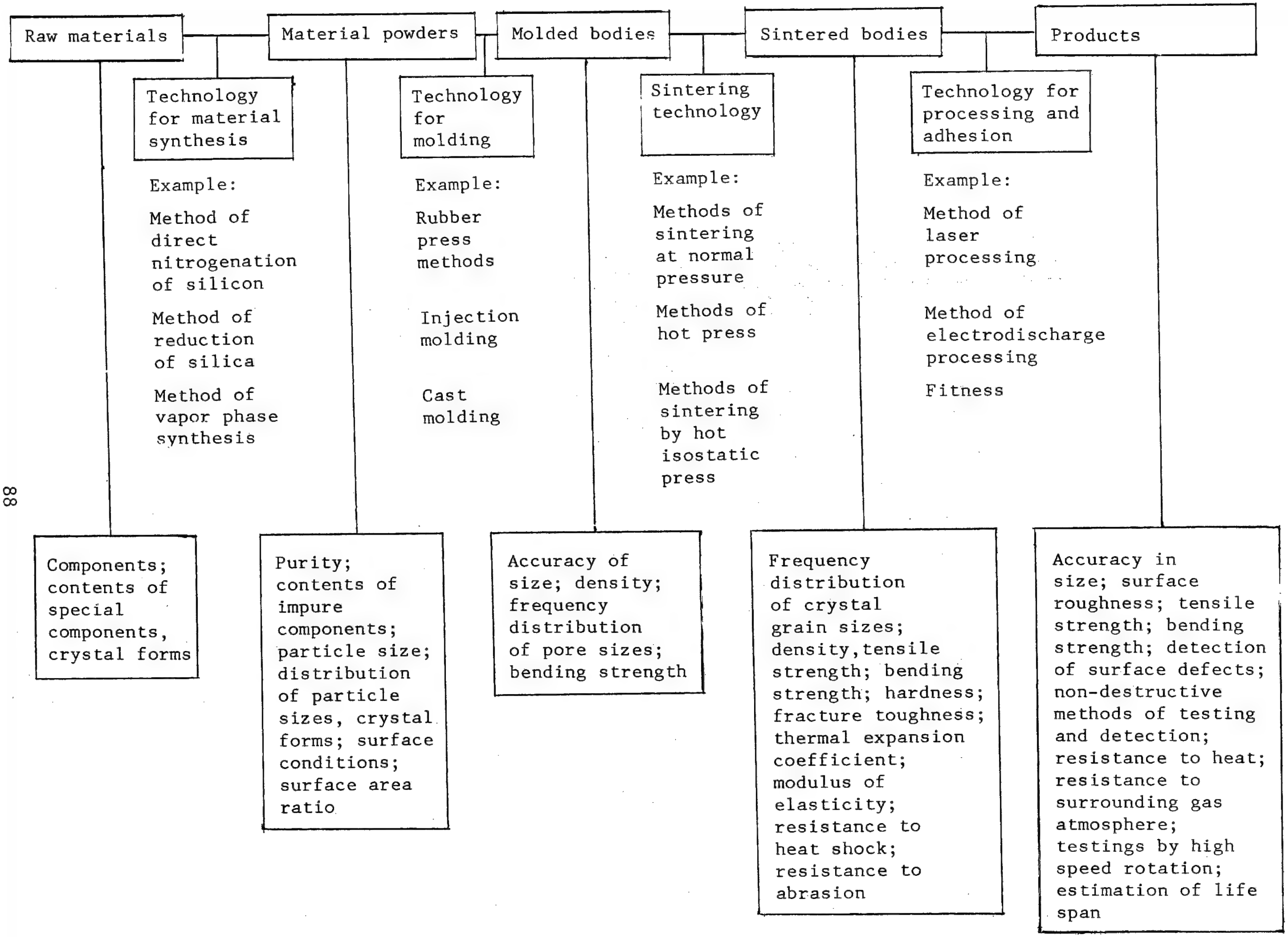


Figure 1. Sequence of Steps in the Manufacture of Fine Ceramics and Relevant Testing and Assessment Items Required

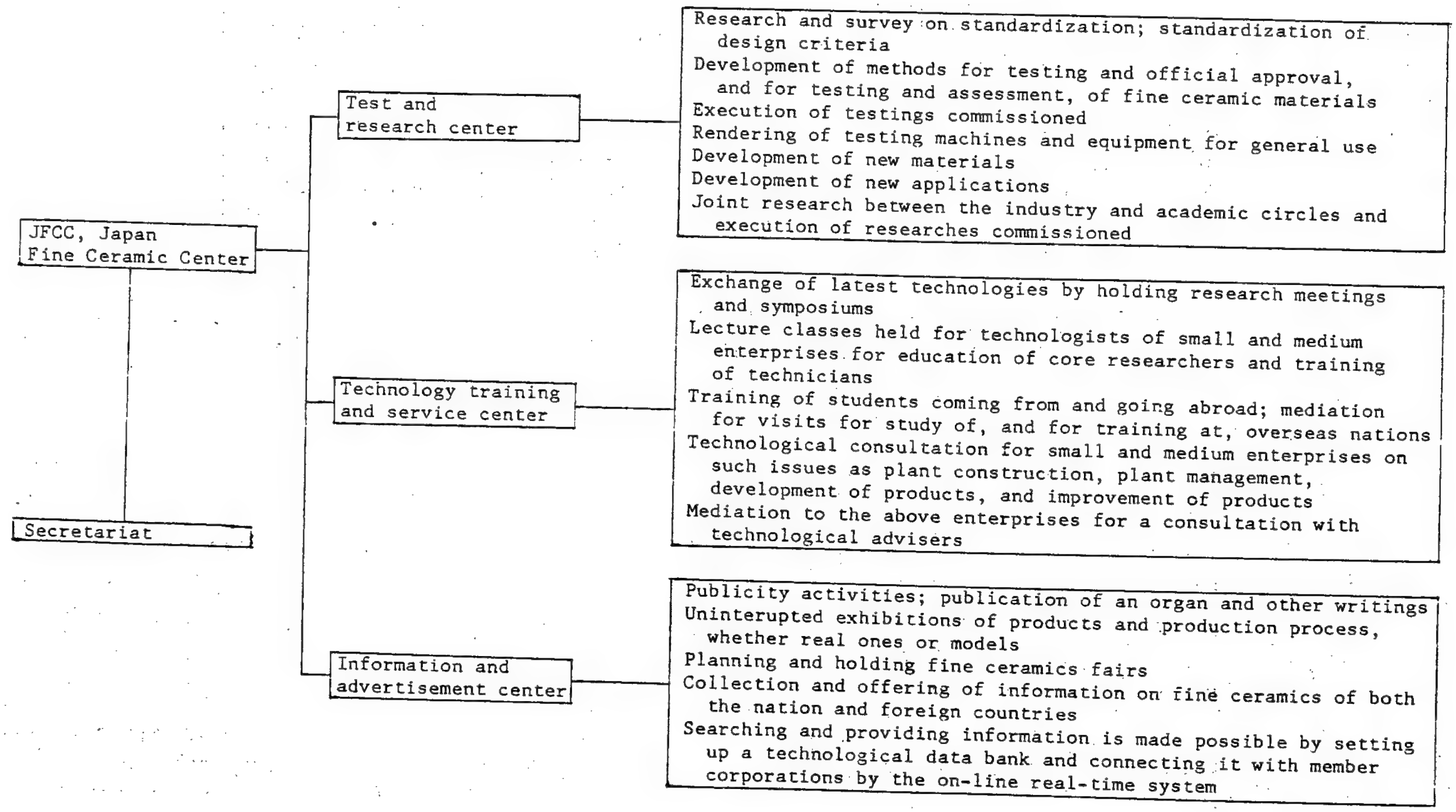


Figure 2. Organization and Contents of Work of the Fine Ceramics Center

objective assessment of test results; setting up of methods of test and assessment for various aspects of the material, therefore, is keenly desired.

3. Improvement in Efficiency of the Assessment Tests

Whereas standardization of the methods of test and assessment for fine ceramic material is of utmost importance for the enhanced application of the material for a structural material as discussed above, corporations involved, etc., meanwhile, are each confronted with the problem of providing for means of carrying out the relevant testings such as installing relevant test equipments and securing of expert analysts.

Expenditure on this equipment, however, is enormous since test and assessment items are very large in number and test facilities multifarious in kind while some of these facilities are only infrequently used. Researchers also have to engage themselves in the relevant analysis often with no time to spare for other researches. These impose a substantial financial burden even on large-sized corporations and serious problems on small- and medium-sized corporations in particular. The development of materials resistant to high temperature, for instance, involves a creep test machine, an electron microscope, surface analysis equipment, a fatigue tester and a machine for testing corrosion at high temperature as the least requirements with the cost for providing this equipment alone at around Y1.0 to 1.5 billion.

For the above reasons, it is necessary to set up a special test and assessment organ, facilities for which are commonly owned, such that costs of testing are reduced and efficiency enhanced. One can also expect that the organ provides data of higher credibility than those produced by each of the corporations and, further, that a buildup of know-how on the test and assessment by the relevant organ permits the organ not only to make testings required but also to offer advice to each of the corporations for the possibility of applications of the relevant fine ceramic materials and thus to play a major role in carrying out tests and assessments with ease. It is, therefore, concluded that setting up such a test and assessment organ is imperative for the facilitation of the relevant test and assessment.

4. Setting Up a Foundation, a Fine Ceramics Center

Under the circumstances, in a concerted effort of the local industry, academic circles, and municipalities concerned, moves gathered momentum, in the Chubu District, for setting up a comprehensive center for fine ceramics. In April 1984, began a preparatory council for setting up a fine ceramic center, sponsored by the local industry of the Chubu District such as the Federation of Economic Organizations of the Chubu District and the Nagoya Chamber of Commerce and Industry, and supported by the Fine Ceramics Association which is made up of corporations of the ceramic industry across the nation. In response to this civilian move, the International Trade and Industry Ministry obtained an appropriation in the fiscal 1984 budget for the cost of the commissioning of a survey in connection with the setting up of the fine ceramic center and rendered an active support to the detailed survey conducted by the above preparatory council. The council, in consequence, completed required examinations including those for the site involved and, on 22 April

1985, held a general assembly for the setting up of the center, followed, on 7 May by the approval by the above ministry for the relevant project.

Presently, brisk moves for setting up similar centers of other new materials are being seen and it is hoped that setting up these centers will speeds up development of fine ceramics and other new materials.

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SCIENCE AND TECHNOLOGY POLICY

MITI BUDGET FOR TECHNOLOGY, INFORMATION, ENERGY OUTLINED

Tokyo FINANCE in Japanese Jun 85 pp 47-57

[Article by Masahiro Akiyama, budget officer, Budget Bureau, Ministry of Finance: "Budget for Technology, Information, and Energy"]

[Text] Preface

1. Technology, Information, and Energy Offer Many Subjects for R&D

The city is now flooded with slogan-like phrases such as "High-tech's first year," "Highly advanced information society" and "Security for energy resources," and in fact it is true that each one of them is a considerably important issue.

Technology development is indispensable to Japan for maintaining continued economic growth in the future, since its land is limited and natural resources are scarce. Recently, the evolution of the information-oriented trend in Japan has become so noticeable that the government has been called on to take proper measures to cope with the situation. In addition, since Japan depends on overseas sources for the major part of its energy supply, it should make an unfailing effort to ensure its economic security.

The areas of technology, information, and energy have one common characteristic: they provide abundant subjects for research and development. If the budgets or measures for these three areas were temporarily suspended, present economic and social activities would not be immediately disordered. However, the abundance of R&D subjects in these areas will affect Japan's future in the 21st century.

2. Top Priority in MITI's FY 1985 Budget

Measures concerning technology, information, and energy are widely taken in fiscal, taxation, and financial areas in addition to administration through legislation, but this article will cast a spotlight on budget expenditures. The budgets for technology, information, and energy are appropriated not only in the general account such as science and technology promotion expense, the expense for energy measures and so on by a number of ministries and agencies, but also in the special account as expenditures. For convenience this article will discuss the appropriations for technology, information,

and energy budgeted by the Ministry of International Trade and Industry in its general and special accounts.

In its FY 1985 budget request MITI placed the highest priority on appropriations for technology development by calling it "1-chome 1-banchi" [translator's note: the initial number of address which indicates the most important item in the budget request]. The ruling political party also stressed the need to promote science and technology. Both of them are aware of the importance of research and development for technological innovation. Explanation will be made with emphasis on the budget for technology development as follows.

1. Budget for Technology Development

1.1 Background Calling for Technology Development

1.1.1 Arrival of New Age of Technological Innovation

Schumpeter, an economist, reported the theory that innovation (it was translated as technological innovation in the Economic White Paper) is an important factor of economic development and draws public attention. Innovation does not occur at all times, but once it does, it can occur like floodwater.

Its examples are the invention of the steam engine, which triggered the Industrial Revolution late in the 18th century, the utilization of electric energy during the period from late 19th century to the 20th century, and presently ongoing technological innovation in the fields of atomic power and electronics in the late 20th century. New materials, biotechnology (bioengineering), and microelectronics are said to be the three pillars of technological innovation for entering the 21st century.

Since there is no answer to the question, if a future exactly exists in these areas, an outcome can eventuate innovational [as published]. Nevertheless, there are various provisional estimates of their respective market size.

With respect to new materials, their market size in 2000 is estimated at Y5.4 trillion compared to Y0.5 trillion in 1981. If the existing market for products related to basic materials of Y4.8 trillion is added, it is estimated to reach Y10.2 trillion (the report of MITI Industrial Structure Seminar in March 1984). The market size of biotechnology is estimated to expand to Y4.2-6.8 trillion in 2000 (Agency of Industrial Science and Technology's report in 1981). Electronics has already shown rapid development. As of March 1983, the number of general purpose computers installed was 128,000 units, the number of personal computers shipped in FY 1983 was 1.14 million units, and the software held by business enterprises was 39 million sets as of March 1982, all of which show an annual growth rate of over 20 percent. The market size of the information processing industry is estimated to expand to Y2.5 trillion by 1988, two times the Y1.1 trillion in 1983 (MITI).

As illustrated above, technological innovation appears robust, but reality is not so easy. In electronics the competition in technological development is fierce and the possibility exists that new technology can become outdated

the following day. Although biotechnology made a splendid debut, it is said that it is now confronted with great technological problems. While promising products are expected to come out of basic materials in the future, most developers are now found in structurally depressed industries.

1.1.2 Present Status and Task of Technology Development in Japan

The development of technology is generally divided into three phases: basic research, application research, and development research. Basic research is theory-proving study to discover new knowledge without specific subjects, typical of which is the research being conducted in universities. Application research studies the possibility of putting theories to practical use in order to meet special needs, based on the results (seeds) of basic research, which is most applicable to the research being carried out at national research institutes or commissioned by the government. Development research is aimed at commercializing the results of application research and is being actively carried out by private enterprises.

With respect to the present status of research and development in Japan given in the survey report by the prime minister's office, total R&D expenditure in FY 1982 was Y5.9 trillion, 2 percent of GNP, of which corporations spent Y4 trillion, two-thirds of the total. While businesses spent over 70 percent of the total R&D expenditure on commercialization, they allotted only Y0.2 trillion for basic research (refer to Table 1). It is, therefore, pointed out that the government share in research expenditures is low and basic research is far behind. Table 2 indicates research expenditures borne by the governments of advanced countries and their ratios. Meanwhile, the government share in the FY 1982 budget was Y1.9 trillion, including the shares of local bodies and expenditures for research on cultural sciences, according to a provisional estimate. It is needless to say that the differences in tax ratios should not be overlooked in international comparison.

After the war, Japan positively introduced results of basic research and application research from advanced countries, including the United States, in the form of technology introduction. On this basis it has engaged in research and development for commercialization and strengthened marketing and exporting capabilities to achieve rapid economic growth. However, since Japan has grown to be the second economic power in the free world and is still under the condition where trade friction is not easily solved, it seems that Japan can no longer depend on technology introduction following the existing pattern. Also, demand is growing stronger that Japan tax its own strength in basic research and contribute to the world economy. In this connection, it is felt that the time has come for Japan to conduct thorough discussions on the way that research and development should be undertaken.

Table 1. Present Status of Research and Development Expenditures in Japan (1982)

(Unit: trillions of yen)

Phase \ Researcher	Corporation	Research institute	University	Total
Basic research	0.2 (5.5)	0.1 (12.4)	0.5 (51.0)	0.8 (13.9)
Application research	0.9 (21.9)	0.3 (31.5)	0.3 (34.9)	1.5 (25.5)
Development research	2.9 (72.6)	0.5 (54.1)	0.1 (6.9)	3.5 (59.2)
Total	4.0 (100.0)	0.9 (100.0)	0.9 (100.0)	5.9 (100.0

Note: The numbers in the parentheses are the ratios (percent) of expenditures broken down by research phase of the researchers.

Source: Prime Minister's Office (1983 Survey Report on Scientific and Technological Research)

Table 2. Government Share in Research Expenditures in Advanced Countries

Country \ Item		Government share in research expenditure	Ratio of government share	Government share in research expenditure excepting defense research expenditure	Ratio of government share excepting defense research expenditure
		Trillion yen	Percent	Trillion yen	Percent
United States	(1983)	9.6	46.0	4.5	28.6
United Kingdom	(1981)	1.3	49.8	0.6	30.3
West Germany	(1983)	1.8	42.3	1.7	39.9
France	(1983)	1.5	57.8	1.0	46.3
(reference) Japan	(1983)	1.7	24.0	1.7	23.6

Note: Cultural and social sciences are included.
The numbers for the United States and West Germany are estimated values, those for France are preliminary report values.

Source: Agency of Industrial Science and Technology (The Trends of Main Indices of Japan's Research and Development Activities)

1.2 Contents of Technology Development Budget

1.2.1 Position of MITI Budget for Technology Development

According to classification by main expenditure items in the FY 1985 general account, the expenditure for the promotion of science and technology amounted to Y381.6 billion, of which Y59.1 billion was budgeted for MITI. Other than the MITI budget, considerable amounts of appropriations are given for the promotion of science and technology. The Science and Technology Agency made appropriations for atomic power and space development projects, the Ministry of Education for various university research activities, and the Ministry of Health and Welfare and the Ministry of Agriculture, Forestry, and Fisheries for research and development projects under their respective jurisdiction.

With respect to the MITI budget for technology development in a broad sense, the general account totals Y73.6 billion, as indicated in Table 3, including appropriations for the promotion of science and technology and measures for energy and small and medium enterprises. The overall special account totals Y119.6 billion, including the special accounts for the promotion of electric power development, the measures for coal and substitute energy for oil, and industrial investment. The total of the general and special accounts amounts to Y193.2 billion. The government's overall science and technology-related budget stands at Y1,521.6 billion on this basis. In the case of MITI, its FY 1985 general account budget decreased by Y1.7 billion from a year ago due to the shortage of financial resources, but the aggregate budget sum, including the special account, shows an increase of Y21.7 billion from the previous year. Thus, MITI has distributed its budget to technology development on a priority basis.

Explanations follow of the main items of the technology development budget totaling 193.2 billion yen, combining the special and general accounts, which includes those items applicable to the appropriations for information and energy to be described later.

1.2.2 Theme-selective R&D

Theme selective R&D means to successively adopt various themes for research and development from a given scheme. A typical one is the general research activities being carried out by the Industrial Science and Technology Agency and the national research institutes under its jurisdiction at per capita and special expenses. Description will be made here, excepting those general research activities, of the presently spotlighted research and development systems of the next-generation industrial-infrastructural technology and large-scale industrial technology (abbreviated to a large-scale project).

1.2.2.1 Research and Development of Next-Generation Industrial-Infrastructural Technology

This research and development activity, started in FY 1981, is aimed at promoting the research and development of infrastructural technology indispensable to establishing the next-generation industry expected to grow in the 1990's through industrial-educational-official cooperation utilizing the

Table 3. MITI's Technology Development Budget

(Unit: 100 million yen)

Item	FY 1985	FY 1984	Increase/ decrease
General account	736	753	Δ17
Special account	1,196	962	234
Total	1,932	1,715	217
(Main items)			
1. Theme-selective R&D			
(1) Basic technological research for next-generation industry	64	60	4
(2) Large-scale projects	141	111	40
(3) Technological research on medical and welfare equipment	7	7	0
(4) Industrial Science and Technology Agency's expenditures for general research activities	152	151	1
2. Individual projects			
(1) Fifth-general computer	48	51	Δ 3
(2) Civil transport plane development (YXX)	14	14	0
(3) Jet engine development for civil aircraft (V2500)	38	40	Δ 2
3. Energy-related R&D projects			
(1) Sunshine Project	398	368	30
(2) Moonlight Project	111	96	15
(3) Other projects included in coal and oil special account and electric power development special account	566	530	36
4. Environmental improvement for private technology development activities			
(1) Subsidies for R&D of important technologies	13	13	0
(2) Measures for small and medium enterprises, including subsidies for technological improvement	44	41	3
(3) Basic Technology Research Promotion Center (tentative name)	100	--	100

Table 4. Themes of Basic Technology Research and Development for Next-Generation Industry

1. New materials

    a. Fine ceramics
    b. High efficiency high molecular separation film material
    c. Electroconductive high molecular material
    d. High crystalline high molecular material
    e. High performance crystallization control alloy
    f. Composite material
    g. Photo-reactive material (new theme)

2. Biotechnology

    a. Bioreactor
    b. Large-scale cell culturing technology
    c. Recombinant DNA utilization technology

3. New functional elemental devices

    a. Super lattice device
    b. Three dimensional IC
    c. Environment-resistant elemental device

commission system. The themes for research and development were selected from the areas called "the three pillars of technological innovation," i.e., new materials, biotechnology, and new functional elements, all of which are highly innovative, have far-reaching effects, and involve great risks in research and development. At present, 13 themes have been adopted (refer to Table 4).

The FY 1985 budget for this R&D activity amounts to Y6.4 billion; Y25.7 billion has been expended on a cumulative basis for the 5 years since FY 1981 from the public finance funds. The research and development expenditure for each theme is estimated to reach Y5-10 billion during some 10 years. Let us take a few examples. Research and development being conducted on fine ceramics in the area of new materials is aimed at overcoming fragility and improving reliability to produce a fine and hard structural material resistant to high temperature and rust. There is the strong possibility that it will be used in the areas of atomic power, aircraft, space, and internal combustion. In the field of biotechnology, the technology to use recombinant DNA (component substance of genes known as deoxyribonucleic acid) has been developed to create microorganisms useful in the processes of the chemical industry. In the field of new functional elements, a three-dimensional circuitry called a dream IC has been developed, largely improving integration up to a triple-level structure versus the existing one-level structure.

In FY 1985, research and development of optical reaction materials is to be conducted. These materials physically and chemically change their molecular structures or distribution by light and make these changes in a controllable form.

1.2.2.2 Large-scale Project

The system of large-scale R&D of industrial technology, started in FY 1966, is for the government to finance research and development of major industrial technology important and urgent to the national economy and requiring a large amount of funds and time, with the aim of improving the industrial structure and carrying out the development of natural resources in a proper way through industrial-educational-official cooperation under the subcontract system. The R&D cost per theme has recently increased to a Y10-25 billion level.

Fourteen themes have already been completed to date, of which the ultra-high-performance electronic computer development conducted in the 1960's, is said to have led Japan's computer industry to its present great expansion. Other than this, more technologies were developed and are now being used in various fields, including desulfurizing, salt-to-fresh water distilling, and resource recycling. Under this system, the registration of industrial property numbered about 2,500 cases at the end of March 1984.

For FY 1985, Y14.1 billion is budgeted for nine research and development projects, including seven continuing and two new projects (refer to Table 5). Since the inauguration of the system nearly Y200 billion has been expended from government funds.

Table 5. Themes of Large-scale Project System

1. Optical measuring control system.
2. Manufacturing process of basic chemical materials from carbon monoxide
3. Manganese nodule mining system
4. High-speed calculation system for scientific and technological use
5. Automatic tailoring system
6. Hazard robot
7. Surveying system for probing natural resources
8. Integrated water recycling system (new theme)
9. Data base mutual operation system of computer (new theme)

Of the continuing projects, the hazard robot system is intended to develop a system able to rapidly and accurately control from a remote place a robot working in areas not accessible to human beings, such as an atomic power station, the sea, and a devastated area. Another continuing project is designed to develop the process to manufacture basic materials to be used as raw materials by the petrochemical industry using carbon monoxide as a raw material generated from gas synthesized from resources other than oil such as coal and natural gas in anticipation of restricted supply of oil in the future.

The systems of mutual operation of a data base between computers (will be referred to later) and integrated water recycling are planned to be adopted as new development projects for 1985. The latter is called "Aqua-Renaissance 90 Project" and is intended to conduct R&D of an integrated water recycling system fundamentally different from the existing one, using biotechnology and film separation technology, to cope with a social problem such as tight water

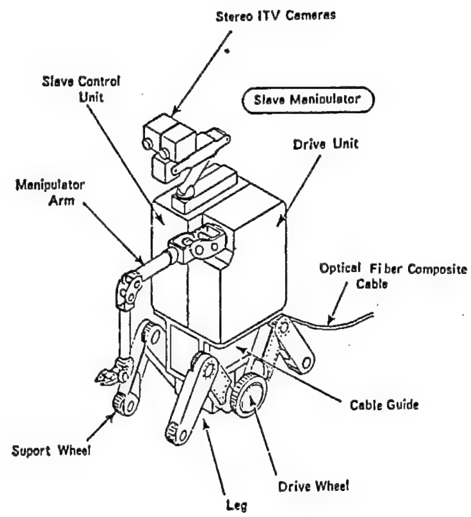

Figure 1. Conception of Hazard Robot

supply extending over an intermediate or long period. This system is arousing great concern internationally; the French Government has expressed its wish to have a French enterprise participate in the project.

1.2.2.3 Research and Development of Technology Concerning Medical and Welfare Equipment

In the areas of medical treatment and welfare, demand for equipment is diverse and large in quantity, but its marketability is quite slim. Moreover, since the project centers on cooperation between engineering and medical science, and developers, mostly small and medium enterprises, cannot afford to take such a risk, the government is undertaking the project directly. Started in FY 1976, the project is presently carrying out R&D on eight themes, including devices for photochemical-reaction cancer diagnosis and treatment, and mobile nursing equipment for the disabled. The FY 1985 appropriation for this project totals Y700 million.

1.2.3 Individual R&D Projects

MITI has a budget for individual R&D projects other than the theme-selective projects, including development of the fifth-generation computer, a civil transport plane (YXX), and a jet engine for a civil airplane (V2500). All of them require a tremendous amount of funding.

1.2.3.1 Fifth-generation Computer Development

This will be referred to in the information-related budget section.

1.2.3.2 Development of Civil Transport Plane (YXX)

The aircraft industry is a typical knowledge-intensive industry using highly advanced technology and has the advantage of high added-value and far-reaching effects on technological fields. In terms of production and sales values the United States is predominant worldwide; Japan is behind the United Kingdom, France, and West Germany. However, its experience with the development of the YS-11 and YX/B767 has contributed considerably in upgrading the level of development technology in Japan.

The commercial transport plane (YXX), to be developed under an international joint project following the YX project, is a noiseless and fuel-efficient plane capable of seating about 150 passengers, for which demand is expected to largely grow from the late 1980's to 1990's. This project started in March 1981; a memorandum was signed in March 1984 between Japan and Boeing which was chosen as a partner in the joint development. The actual start-up (go-ahead) of the project will be dependent upon consideration of the market trend.

For this project, the FY 1985 budget has appropriated Y1.37 billion (national bonds for 380 million). The cumulative amount of appropriations since FY 1981 totals Y6.9 billion, from which subsidies have been granted to the Japan Aircraft Development Association (foundation), the primary Japanese participant in the project. Under the severe fiscal conditions, the initial subsidy of 75 percent in FY 1981 has been annually reduced to 55 percent in FY 1985.

1.2.3.3 Development of Commercial Aircraft Engine (V2500)

This project is to develop jointly with other countries, under the same conditions as the YXX project, a fuel-efficient, noiseless, and pollution-free jet engine with a thrust of 10 tons to be mounted on a commercial plane seating 150 passengers. This project was jointly started in 1980 with the United Kingdom (Rolls-Royce on the part of the United Kingdom) and was expanded in 1983 to a joint project of five countries, including jet engine makers of the United States, West Germany, and Italy. The project is now making headway in expectation of obtaining a type certificate in the spring of 1988.

An appropriation of Y3.83 billion (national bond for Y3.7 billion) has been budgeted for FY 1985. The cumulative amount of appropriations since FY 1980 amounts to Y24.4 billion, from which subsidies were granted to the Japan Aircraft Engine Association (foundation), the primary Japanese participant in the projects. Under the tight fiscal conditions at present the rate of subsidy has been consecutively reduced, arriving in FY 1985 at 60 percent from 65 percent.

1.2.3.4 Others

The individual projects include, other than the above, the development of new technologies for a material-machinery system for collective housing, and a system supporting medical treatment.

1.2.4 Energy-related R&D

In the field of energy, various research and development projects are being carried out. In particular, MITI has two energy-related special accounts, namely, the special account for the measures to be taken concerning coal, oil, and substitute energy for oil, and that for electric power development promotion measures, under which a number of projects are being put into operation. They include projects to develop substitute energy for oil and ensure energy conservation, both comprising two mainstays in research and development contributing to improvement of the vulnerable energy supply structure of Japan that heavily depends on foreign oil. Needless to say, other projects are also being conducted under the two special accounts, aiming at the efficient use of existing energy and its security.

1.2.4.1 Sunshine Project

The Sunshine Project, launched in 1974, represents the research and development of substitute energy for oil designed to reduce Japan's dependence on oil as its primary energy. It is conducting the R&D of solar, geothermal, and coal energy, with the New Energy Development Organization (NEDO) regarded as the core of plant development (refer to Table 6). For this project, Y39.8 billion has been appropriated in the FY 1985 budget. It should be noted that the utilization of atomic power is important, but since this is included in the budget of the Industrial Science and Technology Agency, this article does not intend to refer to it.

In the field of solar energy the development of technology for making a solar cell and its utilization, and a solar system for industrial use is now underway. Regarding geothermal energy, a nationwide survey of geothermal resources is being conducted and a power generating plant using hot water is under development. The field of coal energy centers on a coal liquefaction project and the development of a coal gasification plant. The coal liquefaction project is constructing a brown coal liquefaction plant with a capacity of 50 tons daily in the state of Victoria in Australia under the Japan-Australia joint project, for which Y61.3 billion is budgeted for the period from FY 1981 to FY 1985. In addition, the development of a bituminous coal liquefaction plant with a capacity of 250 tons daily is scheduled to start in FY 1985.

Table 6. Themes of Sunshine Project

1. Solar energy

    a. Commercializing technology of solar ray power generation
    b. Analytical research of solar thermal power generation plant
    c. Solar systems for industrial use

2. Geothermal energy

    a. Nationwide general geothermal survey
    b. Examination of geothermal probing technology
    c. Hydrothermal power generation plant

[table continued]

[continuation of Table 6]

3. Coal energy
    a. Liquefaction plant
    b. High and low calorie gasification plant

4. Hydrogen, oceanic, and wind-power energy

Japan-Australia joint project, for which Y61.3 billion is budgeted for the period from FY 1981 to FY 1985. In addition, the development of a bituminous coal liquefaction plant with a capacity of 250 tons daily is scheduled to start in FY 1985.

1.2.4.2 Moonlight Project

The Moonlight Project, started in FY 1978, represents the research and development activities of energy saving technology, including large-scale R&D of energy saving technology and that of pioneering and basic energy saving technology now underway (refer to Table 7), for which Y11.1 billion is included in the FY 1985 budget.

Table 7. Themes of Moonlight Project

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1. Large-scale energy saving technology research and development project
    a. High efficiency gas turbine
    b. New-type cell power storage system
    c. Fuel cell power generation technology
    d. General purpose Stirling engine
    e. Super heat pump energy accumulation system

2. Pioneering, basic energy saving technology
    a. Electric energy conversion and transmission technology
    b. New aluminum refining technology using blast furnace system

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With respect to large-scale R&D of energy saving technology, the development of a high efficiency gas turbine with a targeted heat efficiency of 55 percent--which will replace the existing turbine with an upper heat efficiency ceiling of some 40 percent--and of fuel cell power generation technology is being carried out. The fuel cell is not the so-called battery, but a power-generating system using the theory of cell-chemical reaction between hydrogen and oxygen. Since its heat efficiency is as high as 40 to 60 percent, regardless of its scale, it allows siting in various places.

In regard to the pioneering and basic energy saving technology, new technology of aluminum refining is being developed.

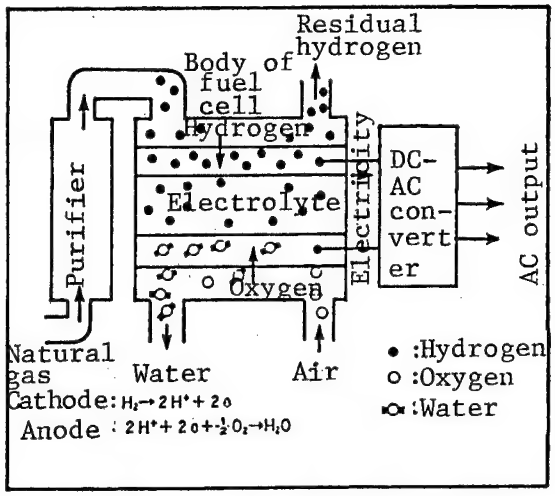

Figure 2. Theory of Fuel Cell System

1.2.4.3 Others

Referring to other projects included in the FY 1985 budget, the special account for electric power development promotion measures provides about Y38.9 billion for the implementation of research proving the reliability of atomic power generating facilities aimed at stepping up atomic power generating, verification tests of light-water reactor improvement technology, confirming surveys of the second nuclear fuel reprocessing plant technology, and the construction of a new type converter and experimental reactor. The special account for the measures concerning coal, oil, and substitute energy for oil provides about Y17.7 billion for implementing tests, examination, research, and development concerning heavy oil processing technology, and coal production and utilization technology.

1.2.5 Environmental Improvement for Private Technology Development

The above-mentioned research and development activities can be said to have the strong color of national project because they are conducted by the government directly or through industry-university-government cooperation. However, it is important to establish a research and development scheme utilizing private resources, viewed from the great part private enterprise can take in Japan's research and development activities. Although the policy instrument for achieving this concerns taxation, finance, and national finance, introduction will focus on government subsidies as follows.

1.2.5.1 R&D Subsidy

This system provides a subsidy as an incentive to an enterprise engaged in any technology development that assures no immediate payback even in the event of a success. Such subsidies include that for the R&D of important technology (Y1.3 billion for FY 1985) to be granted to the private sector in general, that for technological improvement to be granted specifically to small and medium enterprises (Y1.4 billion for FY 1985), and that for a regional undertaking to invigorate technology (Y1.63 billion for FY 1985). In the case of

successful achievement the recipients of subsidies will be obligated to pay back the national treasury from their revenue.

1.2.5.2 Basic Technology Research Promotion Center

As was stated at the beginning, Japan's R&D activities are mainly carried out by the private sector, but are said to be weak in basic research. Therefore, Japan is scheduled to inaugurate the Basic Technology Research Promotion Center in FY 1985 upon approval by a special law to promote basic research or basic technology research utilizing private resources.

The center's functions would be the following: 1) to finance under some conditions, without interest, a technology development project starting mainly from the phase of application research; 2) to invest in a technology development joint project participated in by more than two enterprises starting from the phase of basic or application research, or a basic and pioneering project offering abundant subjects of technological development; and 3) to carry out joint research activities.

As regards funding for the above, since the financial resources for the industrial investment special account will be augmented by transferring one-third of the stock equity of New Den-Den that the government is obligated to hold to the said account, an investment of Y8 billion and a loan of Y2 billion are expected to be available from the same account. Additionally, investments of Y3 billion by the Japan Development Bank and at least Y3 billion by private banking institutions are expected to be available.

The enactment of a law to facilitate basic technological research activities and a revision to the Industrial Investment Special Account Law are necessary to secure the above funds, however, the center is scheduled to open on 1 October of this year. The center is intended to be a legal person under joint management by MITI and the Ministry of Posts and Telecommunications.

1.2.5.3 Technopolis Concept

Technopolis is a new term connecting technology with -polis (city), but it indicates, to be accurate, a region approved for its development plan by the law enacted in 1983 to promote the development of a high-technology industry complex. This is a new-type regional development plan to organically arrange, under the leadership of a local autonomous body, the industries centering on technological innovation in electronics, biotechnology, and new materials, technical colleges and private research institutes.

Fifteen regions each have now been designated as a technopolis, for which various technology development subsidies, tax privileges, and financial facilities are expected to be provided.

1.2.5.4 System Financing by Japan Development Bank and Other Banking Institutions

The Japan Development Bank has a specific loan ceiling to finance the promotion of information-oriented activities and industrial technology, and the upgrading

of the electronic and machinery industries; Y132 billion is earmarked for FY 1985. Moreover, the recent revision to the Japan Development Bank Law has opened the way to finance research and development in addition to the investment in plant and equipment, and strengthened the bank's investment function in the area of technology development, enabling it to invest in the proposed basic technology promotion center.

Other than the Japan Development Bank, the Hokkaido and Tohoku Development Corporation, the Smaller Business Finance Corporation, and the People's Finance Corporation each have a special loan system to finance technology promotion.

2. Information-related Budget

2.1 Advent of High Information Society

Japan experienced from the latter part of the 1960's to 1970 the first information revolution centering on the introduction of computers into industry. However, since the technology of information processing and communications has made great strides and the dissemination of networks has made progress ever since, Japan is considered to be reaching a new stage to be called the second information revolution.

New media in the future will have abilities 1) to cover a larger region through networks, 2) tend toward a two-way system, and 3) diversify the form of information. The analog networks are changing to digital networks and information processing is becoming larger in capacity and higher in speed to technically support these trends. MITI's information-related budget to cope with evolution of the high information society is outlined as follows.

2.2 Contents of Information-related Budget

Although MITI's information-related budget overlaps with part of the budget for the above-mentioned technology development, it amounts to Y17.4 billion for FY 1985. The main items covered are as follows.

2.2.1 Research and Development of Fifth-generation Computer

This is officially called electronic computer basic technology development. The computers prior to this generation represented the systems to create various functions through software with simple hardware, i.e., the first generation--a vacuum tube, the second generation--a transistor, the third generation--IC (integrated circuit) and LSI (large-scale integrated circuit), and the fourth generation--ULSI. On the other hand, the fifth-generation computer is a system incorporating completely different technology from the existing one, being an epoch-making machine with high level reasoning and talking functions. The FY 1985 budget for this project totals Y4.78 billion. On a cumulative basis from FY 1982 the budget amounts to Y13 billion. Seven to eight more years are estimated to complete the project.

2.2.2 Research and Development of High-speed Calculation System for Science and Technology

This project is being carried out as part of the large-scale projects included in the above-mentioned technology development budget to develop high integration technology for the Josephson junction element, a high-speed element. The Josephson element is an element enabling ultra-high-speed processing at low power consumption by utilizing the phenomenon that the cooling of an element of a certain kind to an extremely low temperature generates superconductivity and electric resistance is reduced to almost zero. The FY 1985 budget for this project totals Y2.75 billion.

2.2.3 Research and Development of System for Mutual Operation of Data Base Between Computers

With the evolution of new media, the establishment of a basis to allow mutual operation over the existing standards of equipment and systems becomes important. At present, even in one media the quality of equipment parts, letter codes, data formats, transmission methods, and interfaces are varied, and it is much more so between a number of media. In order to ensure fair competition and user facility or choice, it has become necessary to work out various standards to provide a minimum and unified connection between hardware and software of new media-related equipment and a system.

The project, adopted as a new item for FY 1985 (its appropriation is Y200 million), is planned to be carried out as part of the large-scale research and development project system.

2.2.4 Measures for Information Processing Promotion Association (IPA)

A subsidy of Y2.35 billion is appropriated in the FY 1985 general account budget for the Information Processing Promotion Association, established in 1970 to promote the information processing business. The Association is engaged in the development of a specific program which is difficult for private enterprise to develop, a general purpose program for small and medium enterprises and software maintenance technology.

In the meantime, the demand for software is increasing in Japan, but since most suppliers are developing it manually, it is highly possible that a demand-supply gap of software or absolute shortages of engineers such as programmers will develop in the near future. To cope with such a situation, it has been decided to set up in FY 1985 an industrialized system designed to mechanize and automate software production by introducing a computer into the software development process. To this end the relevant law is being revised to expand the scope of activity of the association and an investment of Y2 billion is expected to be made from the industrial investment special account.

2.2.5 New Media Community Concept

The new media community concept is to promote the setting up of various information systems utilizing new media with the emphasis on software as compared

with the teletopia being promoted by Ministry of Posts and Telecommunications which puts the stress on hardware.

Eight regions were each designated as a new media community as of 1984 and six more regions are expected to be added in FY 1985, supported by a budget totaling Y700 million.

3. Energy-related Budget

3.1 Background of Energy Measures

The appropriation for energy measures in the classification of main expenditure items of the general account totals Y628.8 billion. Comparable large amounts of appropriations are Y165.7 billion for the promotion of atomic power peaceful utilization research, and Y455 billion included in the special account for the measures concerning coal, oil, and substitute energy for oil.

Reference will be made as follows of the MITI budget measures for oil.

As is generally known, Japan's dependence on oil as its primary energy source is high, being 62 percent in 1982, and the dependence on oil imports is 99.7 percent. This situation, however, has improved markedly since the degree of dependence dropped from 75 percent in 1977 to 62 percent 5 years later. But Japan's vulnerability in energy supply should not be considered to have improved. Although the world's oil demand has continued to decrease annually since 1980 due to energy saving, the promotion of substitute energy for oil, and economic stagnation, it turned upward again in 1984 and an undersupply of oil is predicted to occur in 1990.

Japan's basic oil policy lies in technology development comprised of three pillars: the development of oil resources such as oil prospecting, oil stockpiling, and the development of substitute energy for oil.

3.2 Contents of Special Account Budget for Measures for Coal, Oil, and Substitute Energy for Oil

This special account includes the coal account and oil and substitute energy for oil account; the latter will be explained hereafter as it is the center of this theme. The total amount of FY 1985 appropriations of this account is Y472.4 billion, an increase of Y23.4 billion over FY 1984.

3.2.1 Oil Development

Japan's self-developed crude oil accounts for some 10 percent of its total crude oil imports. To step up self-development of a stable supply source, the Japan Petroleum Development Corporation is carrying out investment and finance for oil prospecting, basic surveys of domestic oil and natural gas resources, and research on development technology of oil shale.

The investment and finance for oil prospecting for FY 1985 amounts to Y141 billion, and investment in the corporation from the coal and oil special

account to provide financial resource to the corporation totals Y105 billion. The appropriation for oil development from the same account amounts to Y132.1 billion, including other expenditures for technological research and development.

3.2.2. Oil Stockpiling

In view of the great weight oil carries as the primary energy supply and the high degree of dependence on Middle East crude oil imports, the promotion of oil stockpiling to ensure Japan's economic security is an important policy issue.

Japan's oil reserves at the end of last year totaled 68.7 million kl, a 127-day stock, including private reserves of 52.07 million kl and national reserves of 16.63 million kl. However, Japan is requested to increase its oil reserves, since this amount of reserves equals only two-thirds of the average amount of IEA-member countries.

Since the private sector has already achieved its obligated 90-day stock of oil, the government now must increase its stocks. In achieving its goal of 30 million kl of oil reserves, the government plans a 3 million kl increase in FY 1985 to bring the total to a level of 20.5 million kl at the end of that year.

The construction of national stockpiling bases is now underway, and the building of five land bases for oil tanks and two bases on the sea are planned to be launched. The expenditure for surveys necessary for constructing underground stock bases is included in the FY 1985 budget. Because stockpiling both on the sea and underground is a new experience for Japan, its results are awaited from a technological standpoint. The stockpiling-related appropriations included in the FY 1985 special account amounts to Y263.3 billion.

3.2.3 Technology Development and Other

Although it was mentioned in the technology development budget section, the budget for oil-related technology development and distribution amounts to Y20.3 billion.

The above is the content of MITI budgets for technology development, information, and energy. It is added lastly that MITI, taking into account the severe fiscal conditions, intends to distribute the budgets on a priority basis: the general account less exceptional items transferred to the special account at a minus 6.2 percent from the previous year, by formulating a minus budget in 4 consecutive years for the measures for small and medium enterprises from the standpoints of priority and effectiveness, and making thoroughgoing adjustment and rationalization of subsidies.

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TRANSPORTATION

REASONS FOR AUTOMOBILE EXPORT RESTRICTIONS EXPLAINED

Tokyo TSUSAN JOURNAL in Japanese Jul 85 pp 50-52

[Article by Naoki Kuroda, chief, Automobile Division, Machinery and Information Industries Bureau, MITI: "Why Export Restrictions Are To Be Continued--Problems of Automobile Exports to United States in Fiscal 1985 Summarized"]

[Text] MITI has disclosed its planned self-control restriction on car exports to the United States in fiscal 1985 after 4 succeeding years of the current self-control restrictions on car exports under Japan's independent judgment for restriction not to exceed 2.3 million, as a transitional measure to the future of free trade. MITI's idea as to why a self-control curb is to be continued after 4 years of restriction is summarized in the following.

Measure of Fiscal 1985

Self-control export restrictive measures on passenger car exports to the United States have continued for the past 4 years since 1981. This measure was taken based on a broad view that the U.S. automobile industry, which had been in difficulty during 1980-81, would attempt to recover, and that the Japanese side would maintain the free-trade system to further the future expectation of U.S.-Japanese economic development.

Respective related circles have been interested in how passenger-car exports to the United States would be handled after fiscal 1985 when the term of current measures expire. However, MITI publicized the minister's statement "on passenger-car exports to the United States in fiscal 1985" disclosing MITI's policy of continuing guidance on car manufacturers' export within the purpose of maintaining a moderate export for fiscal 1985 also.

The contents of the guidance are as follows:

The guidance stands solely on Japan's independent judgment, differing from the measures of the past 4 years,

To be a transient measure for the materialization of free trade without causing any confusion,

Within the range of not exceeding 2.3 million cars,

MITI to provide guidance to respective enterprises independently as it had done in the past. This would thus realize a moderation in exports.

After determining the above policy, allocation of passenger-car quotas to the manufacturers for exports to the United States was completed on 26 April to finalize the problem of passenger-car exports to the United States for the time being.

In relation to this problem, as various arguments had arisen from varied sources during the several months of process up to policy determination, our intentions regarding this determination are summarized in the following.

Why Export Restriction Is To Be Continued

As explained at the beginning, in the past 4 years the exercising of self-control measures on automobile exports was on the premise of the United States attempting to reorganize the automobile industry, and Japan in a sense cooperating in this effort. It is true, however, that there were opinions that recent condition reflects no further need for Japan to continue exercising self-control export measures.

Observing recent trends, the U.S. automobile market has recovered at a rate exceeding 10 percent for the 2 successive years of 1983 and 1984, and this, accompanied by a significant reduction of the break-even point of U.S. enterprises, caused them to increase their profit markedly so much so as to make a record-breaking profit. On the other hand, in the area of employment, layoffs, which at one time were at a level of 250,000, have nearly stabilized at the 50,000 level. Under such prosperous conditions of the industry, Japanese cars are being sold at premium prices as a result of Japan's exercising self-control export measures, and there is a logic that further continuation of the self-control export measures may induce problems from the viewpoint of consumer's benefit.

It is known that such a view was strengthened by the 1 March statement of President Reagan that "extension of the restriction will not be requested of Japan."

It is natural as far as we are concerned that the market mechanism should function basically in the field of auto trade under the principle of free trade. We also agree with the view that the 4 years of self-control export measures resulted in fully achieving the intended objectives of cooperation in the reconstruction of the U.S. auto industry. The problem is that when the restrictive export measures are lifted under conditions where such demands for Japanese cars are very strong, export of Japanese cars may increase suddenly in great numbers that might cause some confusion in the auto industry in the United States. Should such conditions occur, it is clear that it would not be desirable for the long-term development of the automobile industry, which occupies an important position both in Japan and in the United States, and that there are apprehensions that such conditions could lead to new protectionism.

Having heard from manufacturers which export cars to the United States that their export forecast in fiscal 1985 will reach a very high level exceeding 2.7 million, it is anticipated that a very serious situation will result should exports be carried out as forecast by each company, respectively. Therefore, MITI has determined it would be necessary to impose certain transient measures after fiscal 1985 for a soft landing for the purpose of avoiding the situation of a sudden increase in exports and to materialize free trade without confusion.

The writer would like to make some comments regarding the criticisms made of the above decision after deciding on the measure. The first is on the opinion about "why a status of free competition could not take place at the end of fiscal 1984 when the self-control export measure expired, even if it were for a short period." Of course, we have basically studied a policy of returning to a stage of free trade in groping for various possibilities. Considering the levels in the market and the imposed limitations in fiscal 1984, however, we could not disregard the significant gap between demand and supply, and with certain differences existing in the margin for additional supply among the Japanese manufacturers, we arrived at the conclusion that a chance of needless friction and confusion would become larger were we to suddenly have free export.

As for the second opinion that "MITI's continuation of restrictions in fiscal 1985 is taken as though MITI is handling the automobile industry as a child," and "as the automobile industry is an adult industry, it should be a matter of course that a moderate export should take place," we feel that such criticism is not appropriate. It is natural that enterprises compete with each other, and there is no enterprise that will refrain solely by itself. The arguments that the automobile industry is a child or an adult with regard to this measure is annoying both to us as well as to the automobile industry.

A Level of 2.3 Million Vehicles

In enacting the measure at this time, the actual level of passenger-car exports to the United States was settled at 2.3 million vehicles, an increase of 450,000 vehicles against the 1.85 million in 1984. This figure was decided by an overall consideration of the trade-off requirements of one party protecting the consumer's benefit by effective competition through free trade, and for the other party to avoid a sudden increase of exports so as not to cause any confusion in the United States automobile industry. When importance is placed to the former, free export is desirable, and to the latter the lowest possible figure is desirable. The level of 2.3 million is said to be the result of seeking to satisfy both sides to the very extreme limit. Also, judging from the situation of demand and supply, such a level of import was determined to be indispensable on the grounds that the Japanese automobile inventory in the United States was at an extra low level as a result of self-control export restrictive measures continuing to 1984, while normalization was required, there was the special situation of requesting large-scale captive-imports as well as the deep-rooted strong demands for Japanese cars.

Soon after the announcement of the measures this time, some enterprises and U.S. labor circles were of the opinion that the figure of 2.3 million might be too large. However, consider that the figure of 2.3 million was the result of prudent thought for the above requirements and that the situation of allocations to be stated subsequently were reviewed.

The Reason To Follow the Past Regulatory System

To maintain moderate automobile exports to the United States this time, the system to provide guidance to each car manufacturer independently was adopted by MITI as in the case of self-control export measures of the past 4 years. This measure was taken as the minimum requirement so each enterprise may avoid any trouble caused in relation to the Antimonopoly Act of the United States as long as the government is providing guidance for restrictive measures in export. Clearance for such a guidance system in relation to the U.S. antimonopoly law had already been confirmed by the U.S. Department of Justice. However, the view of the U.S. Government on this matter was reconfirmed for assurance sake. According to a letter dated 26 April from the Secretary of Justice, Mr Meese, received by the Japanese Government, it was confirmed that so long as the system is the same as that in the past, the view of the U.S. Department of Justice will be the same as before and there should be no problem in relation to the antimonopoly law.

Moreover, there was also a critique that if it was necessary to have some restrictive export measures, some system other than that of the past 4 years could be implemented. For instance, why could not the automobile industry impose a self-judging, self-adjusting control, or if the government were to be involved, why not some system different than in the past--namely, a somewhat softer system? Neither method was thought to be acceptable when considering the antimonopoly law. Especially regarding the relationship of the U.S. antimonopoly law, the reply would be in the negative.

With regard to self-judgment and self-control by the automobile industry, no one would say that determination of the quantity of export by the enterprises themselves would be in violation of the antimonopoly law, except in cases of individual enterprises independently aiming to moderate exports. Furthermore, on the point of separate systems under government control, such as weather forecast systems, intergovernmental negotiating systems or others, it has been pointed out that such opinions are known to have arisen from confusion in relations between governments and relations between governments and enterprises.

Idea on Allocation Different From the Past

For implementation of this measure, MITI on 16 April notified each manufacturer exporting cars to the United States of the permissible number of cars for export in fiscal 1985. The number of vehicles each company can export is confidential to the enterprise and should not be made public. However, with the idea of a general system that differs greatly from the past, additional allocating was adopted reflecting the characteristic of "transitional measures aimed at bringing about free trade."

Namely, contrary to the past allocation which placed importance on past records, this time the allocation is to take into consideration various factors, in addition to past records, with the understanding of the major manufacturers, so that the transition to free trade may take place smoothly. Therefore, it has resulted in a smaller allocation for leading manufacturers, and large allocations for the medium- and small-size manufacturers. Another feature of the measures is that special consideration was given to the so-called captive-import, and almost 40 percent of the entire allocating increment was directed toward this field in consideration of the peculiar situation.

We are hopeful that the measures taken at this time will exercise effectively the transition measures as planned, and that it will lead to free trade as early as possible.

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TRANSPORTATION

BOOMING AUTOMOBILE PARTS MARKET TRENDS DESCRIBED

Tokyo KABUSHIKI NIPPON in Japanese 25 Jul 85 pp 50-53

[Article: "Automobile Parts Stocks, a Popular Market--the 'Second Scene' Is High Finance!"]

[Excerpt] The Growth of Automobile Parts Surpasses That of the Automobiles

It is generally accepted that "Japanese-made cars stand at a premium" in developing nations as well as in the advanced countries of Europe and in the United States due to their increasingly intensified international competitive strength resulted from their strong price competition, quality, and improved performance backed up by high productivity. It is needless to say that these factors were the results produced by constant corporate efforts of individual parts makers, such as development of new products, improved quality, reduction in costs, punctuality in delivery dates, etc.

However, parts makers, obliged thus far to be subject to automobile manufacturers, have gradually gained power, some shaking off the latter's "gravitation." With progress in internationalization and diversification of delivery plus development of prospective parts and new materials, the number of parts makers has increased which boast their independent management.

While the increase of recent automobile production remains stationary at an annual rate of 4 to 5 percent, parts production amounted to Y2,602.7 billion for 1983, a 7-percent increase over the previous year and Y2,893 billion for 1984, an 11-percent increase over the previous year, renewing all-time highs for 2 consecutive years. The increase in auto parts exceeding automobile production has resulted from an improved equipment rate of high-added value by expanded parts exports, the trend of high-class automobiles, progress in car electronics, and an increase in the number of parts per unit. Also responsible is the recovery in truck production due to an increased movement of goods accompanying recovery in the economy and thereby increasing the number of larger-sized parts. The increase of main parts for 1984 (see Table 1) shows the highest 61.7 percent over the previous year with fuel injection equipment, all the rest displaying a double-digit increase or close to it, demonstrating the boom.

Table 1. Main Automobile Parts Production and Their Rates of Growth (Based on Mechanical Statistics Annual Report)

Item	Amount	Increase over previous year (in percent)
Fuel injection equipment	Y 85.5 billion	61.7
Oil seal	40.9 billion	25.4
Radiator	130.7 billion	26.5
Automatic change gear	141.3 billion	27.1
Universal joint	16.6 billion	56.6
Shock absorber	86.9 billion	11.3
Brake magnification device	54.2 billion	9.1
Instruments	130.3 billion	27.6
Lighting equipment	110 billion	8.9
Airconditioning	408.1 billion	15.1

Trend of Exports to United States Widens Extensively

Also remarkable is the favorable trend in exports. Exports show an unexpected increase due to the strengthened recovery trend of U.S. automobile production in particular and progress in overseas production by Japanese finished car-makers. According to customs statistics, exports recorded an all-time high of $3.4 billion for 1983, a 33.5-percent increase over the previous year, followed by $4.5 billion for 1984, a 31.8-percent increase over the previous year, thus recording increases at a 30-percent level for 2 consecutive years, their upward trend continuing also into 1985. On an area basis, about 50 percent is for the United States, and 1984 saw an increase of a surprising 60 percent over the previous year in exports for the country.

On top of this, exports of automobile parts to the United States are on an upward trend. General Motors Corp. (GM) has been furthering its "Saturn Project" aimed at development and sale of strategic compact passenger cars targeted for 1988, with plans to invest gross operating expenses as great as $5 billion (Y1.25 trillion), while it has disclosed its policy to use Japanese-made parts.

GM inaugurated the "GM Cooperative Association" (joined by 44 companies) in 1983, adopted Japanese-made parts and purchased a total amount of $45 million (Y11.25 billion) in the same year. The amount of the purchase is expected to have reached $90 million in 1984, doubling that of the previous year and likely to double again in 1985.

GM's procurement in Japan centers on electrical apparatus, while the company shows strong interest in items related to functional parts, new materials, and special steels. It is certain that the total amount of delivery will account for Y50 billion annually solely by "Saturn vehicles," and an industrial source predicts that it may reach around Y100 billion. In addition, West European manufacturers are also showing strong interest in Japanese-made parts, thus showing a favorable market trend for Japanese auto parts-makers as well.

Table 2. Performance and Stock Prices of Major Automobile Parts Makers

(Unit: percent and yen)

Company name	Ordinary increased profit rate FY 84	FY 85	Estimated profit/stock for FY 85	Stock value (as of 3 July)
	(percent)		(yen)	
Mitsuboshi Belting, Ltd.	37	5	31	699
*Kinugawa Rubber Industrial Co., Ltd.	31	10	22	341
*NHK Spring Co., Ltd.	15	18	15	527
*Tokyo Press & Die Co., Ltd.	12	6	38	680
Diesel Kiki Co., Ltd.	22	5	14	664
Sawafuji Electric Co., Ltd.	155	33	8	368
*Nippondenso Co., Ltd.	23	10	57	1,390
*Stanley Electric Co., Ltd.	3	4	23	782
*Shin-Kobe Electric Machinery Co., Ltd.	34	12	11	535
The Furukawa Electric Co., Ltd.	--	275	10	417
*Tokai Rika Co., Ltd.	8	7	40	900
*Toyota Auto Body Co., Ltd.	11	6	43	600
Nissan Shatai Co., Ltd.	18	5	32	397
*Kanto Auto Works, Ltd.	5	4	35	530
Topy Industries Limited	428	33	8	308
Tokiko, Ltd.	30	12	15	635
Toyo Radiator Co., Ltd.	8	15	18	430
*Akebono Brake Industry Co., Ltd.	28	10	21	577
*NOK	10	11	17	560
Kayaba Industry Co., Ltd.	34	25	8	336
Nippon Kinzoku Co., Ltd.	12	12	16	452
*Ichiko Industries, Ltd.	6	17	22	410
*Press Kogyo Co., Ltd.	132	50	18	375
*Nihon Radiator Co., Ltd.	28	6	37	495
Pacific Industrial Co., Ltd.	2	10	17	367
*Aisin Seiki Co., Ltd.	9	8	47	830
Aichi Machine Industry Co., Ltd.	15	12	33	417
Atsugi Motor Parts Co., Ltd.	9	5	24	410
Koito Manufacturing Co., Ltd.	11	11	22	641

Note: The *companies are those which have renewed their all-time high profit.

According to industrial circles, the number of Japanese auto parts-makers which have advanced in the overseas area has already reached 150. Their feature is in the shifting of their inroad areas chiefly from Southeast Asia to the U.S. mainland for rapidly increasing local production.

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END